

GUIDE TO FRUIT PRODUCTION

2014–2015

Publication 360



Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment (MOE)

The information in this publication is general information only. The Ontario Ministry of Agriculture and Food and the Ministry of Rural Affairs (OMAF and MRA) do not offer any warranty or guarantee, nor do they assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide. The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.

The pesticide product label is a legal document. It is against the law to use the product in any other way.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada based on following an evaluation of scientific data to ensure that the product has merit and value; and the human health and environmental risks associated with its proposed use are acceptable.

1. Full Registration

Pesticide registrations are normally granted for a period of five years, subject to renewal.

2. Conditional Registration

Conditional registration may be granted for a specified, limited time period, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

The PMRA has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You **MUST** obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Emergency Use Registration**
- **Minor Use Label Expansion**

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAF and MRA or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA website at www.healthcanada.gc.ca/pmra or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The MOE is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09.

All Pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at www.ontario.ca/e-laws or by calling the ServiceOntario Publications Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOE, the classification of pesticide products before they can be sold or used in Ontario. Once approved by the MOE, classified products are posted on the MOE website: ontario.ca/moe.

Certification and Licensing

Growers and their Assistants

For information about certification for growers and training for assistants check the Ontario Pesticide Education Program website: www.opop.ca or call 1-800-652-8573.

Commercial Applicators (Exterminators) and Their Assisting Technicians

For more information about exterminator licensing and technician training, visit:

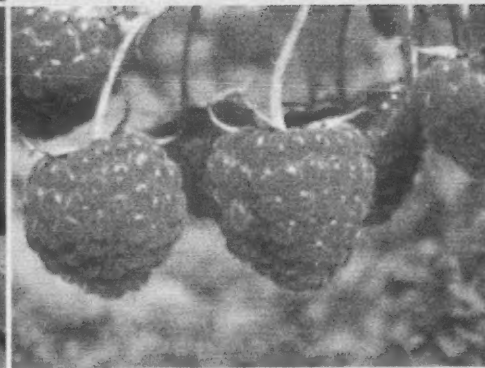
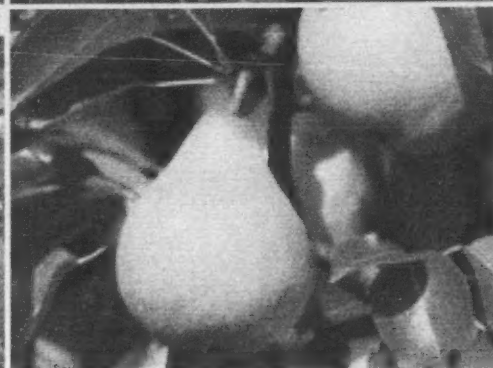
- the Ontario Pesticide Training and Certification website at www.ontariopesticide.com/index.cfm/home-page or call 1-888-620-9999 or 519-674-1575
- the Pesticide Industry Council's Pesticide Technician Program website at www.hort-trades.com or call 1-800-265-5656 or e-mail pic@hort-trades.com
- the Pesticide Industry Regulatory Council (PIRC) at www.oipma.ca.

Cette publication est aussi disponible en français.

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2014–2015

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If you need technical or business information,
contact the Agricultural Information Contact Centre at

1-877-424-1300

ag.info.omaf@ontario.ca

Looking for fruit production information on the Internet?

Check the OMAF website at

www.ontario.ca/crops

This publication contains pesticide control products that have been registered as of December 31, 2013, on fruit crops.

Any supplements to this publication will be posted on the OMAF website at www.ontario.ca/crops.

Acknowledgements

The information contained in this publication has been prepared in consultation with:

- Ontario Pest Management Services Committee
- Ontario Pesticide Education Program
- Ontario Soil Management Services Committee

and personnel of:

- Agriculture Development Branch, OMAF and MRA
- CropLife Canada
- University of Guelph
- Brock University CCOVI
- Ontario Ministry of Environment
- Agriculture and Agri-Food Canada
- several private consulting businesses

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1. Using Pesticides in Ontario

The information in this chapter is updated regularly. For up-to-date information, visit www.ontario.ca/usinpesticides. Some of the information in this generic chapter may not apply to all crops.

**Read the latest product label
before using a pesticide.
Review the *Grower Pesticide
Safety Course Manual*.
Keep detailed spray records.**

Federal Registration of Pesticides

Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act* (PCP Act) and be classified under the provincial *Pesticides Act*. The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticides for use in Canada following an evaluation of scientific data to ensure that the product has merit and value. It also ensures that any human health and environmental risks associated with its proposed uses are acceptable.

The PMRA re-evaluates registered pesticides to determine whether today's health and environmental protection standards are still met when the pesticide is used according to the label. Outcomes of a re-evaluation can be:

- no change to the registration
- amendments to the label (e.g., changes to personal protective equipment requirements, restricted entry intervals, buffer zones)
- modifications to existing Maximum Residue Limits (MRLs)
- elimination or phasing-out of certain uses or formulations
- removal of the registration

The pesticide label is a legal document. It prescribes how the pesticide can be legally used. Labels for all registered pesticides are under "Search Pesticide Labels" on the PMRA website at www.healthcanada.gc.ca/pmra. Ensure you have the most current label and are aware of any re-evaluation decisions.

Regulation of Pesticides in Ontario

The Ministry of the Environment (MOE) is responsible for regulating the sale, use, transportation, storage and disposal of pesticides in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09. All pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at www.ontario.ca/e-laws or by calling ServiceOntario at 1-800-668-9938 or 416-326-5300.

Classification of pesticides

Before a federally registered pesticide can be sold or used in Ontario, it must be classified under the provincial *Pesticides Act*. The Ontario pesticide classification system consists of 11 classes. Ontario's Pesticides Advisory Committee (OPAC) is responsible for assessing new pesticide products and recommending to the MOE the classification of these products. Pesticide products are classified on the basis of their toxicity, environmental and health hazard, persistence of the active ingredient or its metabolites, concentration, usage, federal class designation (e.g., domestic, commercial, restricted) and registration status. The provincial classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario. Once approved by the MOE, classified products are posted on the MOE website at www.ontario.ca/pesticides.

Certification and Licensing

Growers and their assistants

Growers must be certified through the Grower Pesticide Safety Course in order to buy and use Class 2 and 3 pesticides on their farms. They do not require this certification to use Class 4, 5, 6 or 7 pesticides. For information about certification for growers and training for assistants to growers, visit the Ontario Pesticide Education Program website at www.oppep.ca or call 1-800-652-8573.

Commercial applicators (exterminators) and their assisting technicians

For more information about exterminator licensing and technician training, visit:

- the Ontario Pesticide Training and Certification website at www.ontariopesticide.com/index.cfm/home-page or call 1-888-620-9999 or 519-674-1575
- the Pesticide Industry Council website at www.hort-trades.com or call 1-800-265-5656 or email pic@hort-trades.com
- the Pesticide Industry Regulatory Council (PIRC) at www.oipma.ca

Exception for tree care specialists

For more information about requirements in the *Pesticides Act* and Regulation 63/09 for the exception regarding the use of pesticides to maintain the health of trees, see the Ministry of the Environment's website (www.ontario.ca/pesticideban). Click on "Industries and Institutions" and refer to the factsheet *Tree Care Specialists*.

For more information about pesticide regulations, certification and licensing, see:

- Inside front cover of this publication
- Pest Management Regulatory Agency (PMRA) website: www.healthcanada.gc.ca/pmra
- PMRA Pest Management Information Service: 1-800-267-6315 (from within Canada) or 1-613-736-3799 (from outside Canada)
- Ontario Ministry of the Environment (MOE) website: www.ontario.ca/pesticides
- Regional MOE Pesticides Specialist: see Appendix I. *Ministry of the Environment – Regional Contact Information*, on page 302
- Ministry of Agriculture and Food (OMAF) website: www.ontario.ca/omaf
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) website: www.opep.ca
- Ontario Pesticide Training & Certification website: www.ontariopesticide.com/index.cfm/home-page
- Pesticide Industry Council website at www.hort-trades.com
- Pesticide Industry Regulatory Council (PIRC) at www.oipma.ca

Pesticide Application Information

When you decide to use a pesticide, choose the most appropriate formulation and application method for your situation. Use only properly calibrated sprayer equipment. Choose less toxic and less volatile

alternatives when possible. Take all possible precautions to prevent the exposure of people and non-target organisms to the pesticide. Read the most current pesticide label thoroughly before application. The label provides important information, such as:

- directions for use (e.g., rates of application, crops/sites it can be used on, target pests, crop rotation restrictions, total number of applications, droplet size/nozzle type, application equipment, timing, appropriate weather conditions)
- required personal protective equipment (PPE)
- hazard symbols and warnings
- restricted entry intervals
- buffer zones
- precautionary statements
- steps to be taken in case of an accident
- disposal

For more information on hazards, consult the Material Safety Data Sheet (MSDS) or contact the manufacturer.

For more information on pesticide application, see:

- OMAF Factsheet *Calibrating Airblast Sprayers*
- OMAF Factsheet *Adjusting, Maintaining and Cleaning Airblast Sprayers*
- OMAF Factsheet *How Weather Conditions Affect Spray Applications* (website only)
- OMAF Factsheet *Pesticide Drift from Ground Applications*
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) videos at www.opep.ca/index.cfm/learning-resources/videos/
- OMAF Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13
- OMAF Factsheet *Pesticide Contamination of Farm Water Supplies – Recommendations on Avoidance, Cleanup and Responsibilities*

Restricted entry intervals

The restricted entry interval, also referred to as re-entry interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area. This allows any pesticide residue and vapours to dissipate from the treatment location (e.g., field), preventing the possibility of inadvertent pesticide exposure.

The PMRA reviews each pesticide to determine whether the label should include a specific restricted entry interval. If the restricted entry interval is not stated on the label for agricultural crops, assume that the REI is 12 hours. For golf courses and residential turf applications, the spray solution must be dry before entry can occur. Some pesticides have labels that

carry a warning about working in treated crops and provide specific PPE requirements. Follow the label recommendations.

Days to harvest intervals for food crops (preharvest, pre-grazing and feeding intervals)

These intervals state the minimum time that must pass between the last pesticide application and the harvesting of the crop or the grazing and cutting of the crop for livestock feed. If you harvest a crop before the preharvest interval (PHI) has passed, there may be pesticide residues in excess of the maximum residue limits (MRLs) set by PMRA.

"Up to the day of harvest" means the same as 0 days PHI; however, the REI may be more restrictive (e.g., a 12-hour restricted entry interval) and must be observed for harvesting that occurs on the day of pesticide application.

To avoid exceeding the maximum residue limits, always follow the directions on the label.

Buffer zones

Buffer zones, or no-spray areas, are areas left untreated to protect an adjacent sensitive area, such as sensitive terrestrial and aquatic habitats. Generally, a buffer zone is the downwind distance separating the point of direct pesticide application from the nearest boundary of a sensitive habitat.

Leave a suitable buffer zone between the treatment area and adjacent sensitive area. Buffer zones may vary depending on the method of application (e.g., aerial, field boom, air blast). Check the pesticide labels for buffer zone requirements.

Sensitive terrestrial habitats include hedgerows, grasslands, shelterbelts, windbreaks, forested areas and woodlots.

Sensitive freshwater habitats include lakes, rivers, streams, creeks, reservoirs, marshes, wetlands and ponds.

Health Canada's PMRA has an online spray drift calculator that allows applicators to modify the buffer zones specified on the product label based on weather conditions, the category of the spray equipment and the droplet size. For more information, see the Buffer Zone Calculator at www.bc-sc.gc.ca/cps-spc/pest/agri-commerce/drift-derive/calculator-calculatrice-eng.php.

Setback distances for water bodies

It is an offence under the federal *Fisheries Act* to introduce into water any material that may be harmful to fish or fish habitat. To protect these waters, applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned (if the setback distance is not specified on the pesticide label). The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

Protect the Environment

Protect water sources

According to the British Crop Protection Council (BCPC), 40–70% of surface water pesticide contamination comes from mixing and filling areas.

Where possible, load or mix pesticides on impermeable surfaces located safely away from watercourses or environmentally sensitive areas. Collect drainage and runoff and dispose of it safely (*Your Guide to Using Pesticides*, BCPC 2007).

Clean your spray equipment away from wells, ponds, streams and ditches. Apply the diluted rinse water (usually at a ratio of 10:1) to the treatment area (crop), but do not exceed the pesticide rate recommended on the label.

Do not make a direct connection between any water supply (e.g., public supply, wells, watercourse or pond) and a spray tank. Use an anti-backflow device or intermediate system to prevent back-siphoning that could contaminate the water supply.

Immediately contain and clean up any spills to prevent contamination to water sources.

Check the pesticide label for specific instructions on protection of water sources.

For more information on protecting water sources, see:

- OMAF Factsheet *Pesticide Contamination of Farm Water Supplies – Recommendations on Avoidance, Cleanup and Responsibilities*
- OMAF Factsheet *Groundwater – An Important Rural Resource: Protecting the Quality of Groundwater Supplies*
- OMAF Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13

Bee poisoning

Honeybees, native bee species and other pollinating insects are important pollinators for many Ontario crops. Insecticides, some of which may negatively affect bees, require careful management to achieve both pollination and insect control. Growers and licensed commercial applicators can protect bees by following these suggestions:

- Time insecticide applications to minimize bee exposure (e.g., apply postbloom). Daytime treatments, when bees are foraging, are most hazardous. Insecticide applications in the evening are the safest, unless there is evidence of a strong temperature inversion. Under normal circumstances, spraying after 8 PM allows the spray to dry before the bees are exposed to it the next day. Early morning is the next best time, but spraying should be completed well before 7 AM. While honeybees and most other pollinating insects do not usually forage at temperatures below 13°C, bumblebees do. If you plan to spray in the morning, contact beekeepers who have bees within 5 km of your crop and spray site. The beekeepers may then have the option of taking any possible protective action.
- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Do not spray any flowering crop on which bees are foraging.
- To prevent drift toward nearby hives, do not apply insecticides on windy days or when there is evidence of a strong temperature inversion.
- Bees and other pollinators may be poisoned by visiting flowering weeds, trees and cover crops that have come in contact with an insecticide via spray drift or drift of insecticide contaminated dust during planting. Avoid spray drift to flowering weeds that are adjacent to or within the target field. Where possible, mow down flowering cover crops or flowering weeds in and bordering target fields prior to spraying to help safeguard the bees. Control dandelions and other flowering weeds within fields before spraying it or planting seeds treated with an insecticide. Take measures to reduce movement of dust from insecticide seed treatments to flowering trees, weeds and water sources that are in or adjacent to the target field. See the "Field Crop News" blog at fieldcropnews.com for current information on ways to reduce dust movement.
- Beekeepers should remove honeybee colonies as soon as pollination is complete in the crop and before any insecticides are applied postbloom. If the colonies

cannot be removed in time, beekeepers can place burlap or cloth soaked in water at the entrance of the hive to disrupt the flight of the bees for up to 12 hours and provide more time for spray to dry. To help prevent overheating of the hive during this time, keep an opening of 2.5 cm on each side of the hive entrance so bees can still get out and ventilate the hive. Also, the water on the burlap or cloth will help cool the colony.

- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to bees. When there is a choice, choose a product formulation that is less hazardous to bees.
- Always read the most current label for guidance.
- Before applying a pesticide or planting with insecticide-treated seed, advise local beekeepers so they can move colonies out of the danger area, if this is an option. Contact information for the local beekeepers' association in your area can be found on the Ontario Beekeepers' Association website at <http://www.ontariobee.com/community/local-beekeepers-associations>. Other ways to find your local beekeepers are to contact the Provincial Apiarist at 1-888-466-2372, ext. 63595 or see www.ontario.ca/crops and click "Apiculture" and then "Bee Inspectors" for a list of provincial bee inspectors who know the local beekeepers.

Manage drift

Pesticide drift is the aerial movement and unintentional deposit of pesticide outside the target area. Drift results in wasted product, may compromise crop protection and also may adversely affect nearby sensitive environmental areas, crops and wildlife. The following strategies can help reduce the risk of pesticide drift:

- Do not spray when wind speeds are high or gusty. These conditions increase the potential for spray and vapour drift. Check pesticide labels for allowable wind speeds for spraying applications. However, not all labels provide this specific information.
- Constantly monitor wind conditions during spraying using a good-quality wind meter. Record the wind speed and direction. As wind conditions change, you may need to make adjustments to further reduce the drift potential, such as increasing water volume, minimizing nozzle-to-target distance, changing nozzle technology, changing fields because of surrounding influences or stopping spraying until conditions improve.

For more information about spray drift, see:

- OMAF Factsheet *Pesticide Drift from Ground Applications*
- OMAF Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) videos *How to Manage Spray Drift and Spray Drift Reduction Through Air Induction*, available at www.oep.ca/index.cfm/learning-resources/videos/chapter-19-drift-of-pesticides/

- Do not spray during periods of dead calm. Periods of dead calm may occur in early morning or late evening, at which time the temperature is usually cooler and the relative humidity is typically higher, which can result in the spray droplets remaining aloft, like fog. When the wind picks up, these spray droplets can move away from the target area, possibly causing injury to adjacent non-target areas. Off-target drift in calm conditions can occur hours after the spray event was completed.

Temperature inversions create problems for spray applicators because pesticide spray can:

- stay concentrated for long periods over the target
- move with the cool air over considerable distances when the breeze picks up
- move down slopes and concentrate in low-lying regions
- drift unpredictably as the inversion dissipates during the morning

Field air temperatures are often very different from local or regional forecasts, so the most reliable method of detecting inversion conditions is to measure temperatures at, and several metres above, the ground. Spray applicators can recognize a temperature inversion when:

- there is a big difference between the daytime and nighttime temperatures
- early evening and nighttime wind speeds are considerably less than during the day
- sounds seem to carry further
- odours seem more intense
- daytime cumulus clouds collapse toward evening
- overnight cloud cover is 25% or less
- mist, fog, dew or frost occur
- smoke or dust hangs in the air and/or moves laterally in a sheet

Temperature inversions start to form 3 hours prior to sunset, become stronger as the sun sets, and continue until sunrise when the surface warms and air mixing begins. **If you suspect there's an inversion, then don't spray.** Often, warnings for the risk of inversions are stated right on the product label.

- Use the sprayer output specified on the pesticide label.
- Use a nozzle that will produce the droplet size specified on the pesticide label or delivers droplets appropriate for the job. Nozzles that produce fine droplets are rarely, if ever, required.
- Where practical, use air induction/venturi nozzles, which significantly reduce drift compared to conventional nozzles.
- Check the height of the boom to the target or distance from airblast boom to the target. Minimize the distance as much as possible while still maintaining spray uniformity.
- Establish buffer zones for the protection of adjacent sensitive areas. Some pesticide labels will state buffer zone setbacks; follow these carefully.
- Use spray plume protection where practical or available (hoods, shrouds, screens or air curtains).
- Use drift-reducing adjuvants in the spray tank as directed on the label. Mechanical or hydraulic agitations have been shown to reduce the effectiveness of certain drift-reducing adjuvants. Be aware that certain combinations of anti-drift adjuvants and air-induction/venturi nozzles have been shown to increase the incidence of fine droplets that will drift.
- When possible, use non-volatile pesticide formulations or products.

Pesticide Disposal

Empty pesticide containers up to 23 L

Never re-use empty containers.

The Ontario Empty Pesticide Container Recycling Program, an industry-led program, is available free of charge to growers and commercial applicators. Through this program, you can return triple-rinsed or pressure-rinsed plastic pesticide containers up to 23 L to container collection depots located throughout the province. Remove the cap and booklet from the pesticide container before recycling. To locate the closest container collection depot, visit www.cleanfarms.ca, call your local dealer, or contact CleanFARMS at 416-622-4460 (toll-free at 877-622-4460) or info@cleanfarms.ca.

Please note that starting in 2013 this program now includes liquid fertilizer containers up to 23 L in size.

Empty pesticide containers greater than 23 L

Growers and commercial applicators can return pesticide containers that are greater than 23 L in size. Contact your local dealer for details on disposal of these containers, or contact CleanFARMS at 416-622-4460 (toll-free at 877-622-4460) or info@cleanfarms.ca.

Surplus spray mix

The best approach is to plan the spray job accurately to avoid creating a surplus.

When this is unavoidable, dispose of excess spray mix by spraying it on other crops that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that other crop.

If you cannot find another allowable crop to spray, then dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. The diluted solution can be safely applied to the original treated area as long

as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or disposal of surplus spray mix.

Never re-spray the treated field with undiluted spray mix. Spraying an area twice at the same pesticide rate will double the labeled pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Surplus pesticide disposal

Be sure to safely dispose of pesticides that you do not need or cannot use. Options for proper disposal include:

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original, unopened container.
- Hire a waste hauler who is licensed under Part V of the *Environmental Protection Act* to carry hazardous wastes. Look in the Yellow Pages of your telephone directory under Liquid Waste Removal.
- CleanFARMS operates a free Obsolete Pesticide Collection Program throughout the province every three years. To locate the closest collection point and date, visit the CleanFARMS website www.cleanfarms.ca, contact CleanFARMS at 416-622-4460 (toll-free at 877-622-4460), email info@cleanfarms.ca or contact your local dealer for program details.
- Contact your municipality to see if any waste collection days are scheduled and verify whether quantities of agricultural pesticides will be accepted.

Storing Pesticides

Ontario's *Pesticides Act* and Regulation 63/09 provide details on storage requirements for pesticide storage facilities. As shown in Table 1-1, the storage requirements that must be followed are dependent on which classes of pesticides you store.

For pesticide poisonings and pesticide injuries, call:

Poison Information Centre:

1-800-268-9017

(TTY) 1-877-750-2233

For more information, see *Emergency and First Aid Procedures for Pesticide Poisoning* on the inside back cover.

Table 1-1. Requirements for Pesticide Storage Facilities

Storage Requirements	Pesticide Classes			
	2	3	4, 5, 7	6
No contact with food or drink	✓	✓	✓	✓
Not an impairment to health and safety	✓	✓	✓	—
Clean and orderly	✓	✓	✓	—
Warning sign G posted*	✓	✓	✓	—
Emergency telephone numbers posted**	✓	✓	✓	—
Vented to outside	✓	✓	—	—
Limited access (locked)	✓	✓	—	—
No floor drain	✓	✓	—	—
Respiratory protection and protective clothing kept readily available	✓	✓	—	—
Area used primarily for pesticides	✓	—	—	—

Note: Sufficient precautions are needed in your storage area to prevent the pesticide from entering the natural environment. Ensure your floor drain does not enter the natural environment.

* Refer to MOE's website www.ontario.ca/pesticides for requirements for warning sign G. These signs can be purchased from your pesticide dealer/vendor.

** Emergency contact numbers must include telephone numbers for the local fire department, hospital and poison control centre. The number for the MOE Spills Action Centre (1-800-268-6060) should also be readily available.

— = Not required.

For more information about storing pesticides, see:

- OMAF Factsheet *Farm Pesticide Storage Facility*
- OMAF Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) *Grower Pesticide Safety Course Manual*, available at www.opec.ca. Select "Learning."

Pesticide Spills

If a pesticide spill causes, or is likely to cause, an adverse effect that is greater than that which would result from the proper use of the pesticide, you must notify the Ministry of the Environment Spills Action Centre at 1-800-268-6060 (24 hours a day, 7 days a week) and your municipality.

A spill is defined as a discharge of pollutant that is abnormal in quality or quantity, from or out of a structure, vehicle or other container into the environment. An incident such as an overturned pesticide sprayer that results in the loss of the spray

solution to the environment is an example of a spill. A pesticide container that ruptures and leaks its contents is another example of a spill. The discharge or spraying of a pesticide in an unapproved area is also considered a spill.

Before you begin to clean up a spill of any nature, remember to protect yourself against pesticide exposure. Wear the proper protective clothing and personal protective equipment. If the spill occurs inside an enclosed area (e.g., a pesticide storage area or a vehicle during transport), ventilate the area first. Once you have protected yourself and removed other persons or animals from the spill site, take additional measures to stop the spill at the source and prevent it from spreading and/or contaminating watercourses. Specific precautions, emergency contact information and first aid procedures may be found on the label.

For minor spills, it may be possible to rectify the problem:

- **For a liquid spill** – Cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.
- **For a dust, granular or powder spill** – Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.

For major spills, it is essential to stop the spill from spreading.

The cleanup guidelines above may not be appropriate for all spill situations. Once you have contained the spill, follow directions from the manufacturer and regulatory authorities on cleaning the contaminated area.

For information on preventing spills, see:

- OMAF Factsheet *Ways to Avoid Pesticide Spills*
- OMAF Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) *Grower Pesticide Safety Course Manual*, available at www.opec.ca. Select "Learning."

USING PESTICIDES IN ONTARIO

2. Soil Management, Fertilizer Use, Crop Nutrition and Cover Crops

For a complete guide to soil fertility, consult OMAF Publication 611, *Soil Fertility Handbook*.

Crop nutrition is important for production of high-yielding, top quality fruit crops. Nutrients must be dissolved in the soil water for root uptake. Good soil and water management practices are important for a crop's efficient use of nutrients from organic and inorganic fertilizer. The development of a sound soil fertility program begins with the assessment of nutrient needs.

Assessing Nutrient Needs

There are three interdependent ways to assess soil and crop fertility:

- soil testing
- plant tissue analysis
- visual deficiency symptoms

For perennial crops, all three methods are needed to assess and monitor the crop's nutritional status.

Soil testing

A soil test using methods suited to the particular soil type is the best measure of plant-available nutrients. OMAF accredits specific laboratory methods suited to Ontario soils (see Table 2-1, *OMAF-Accredited Soil Tests* on this page). OMAF-accredited laboratories participate in the North American Proficiency Testing Program and must demonstrate their ability to perform these tests accurately.

Soil laboratories may provide additional soil tests not listed in Table 2-1, as well as analyses for greenhouse media, nutrient solutions and water. Testing for soil organic matter can be useful but is not an accredited test. OMAF-accredited soil tests are not available for boron, copper, iron or molybdenum. Tissue analysis of these micronutrients is a better indicator of the nutritional status. For other testing services, contact the soil laboratories listed in Appendix F: *Accredited Soil-Testing Laboratories in Ontario*, page 298.

Table 2-1. OMAF-Accredited Soil Tests

Nutrient Analyzed	Test
phosphorus	sodium bicarbonate extractable
potassium magnesium	ammonium acetate extractable
manganese	index of soil pH and phosphoric acid extractable manganese
zinc	Index of soil pH and DTPA extractable zinc
pH	saturate paste extract
lime requirement	SMP buffer pH
soil nitrate	potassium chloride extraction

When to sample

Always take soil samples before you plant fruit crops. Where pH adjustments may be necessary, sample 2 years before planting so that adjustments can be made. After establishment, sample each field once every 2 or 3 years. In sandy soils, consider checking soil potassium levels more frequently.

Soils may be sampled in the summer or fall. Sample at the same time each year for more consistent results. Late summer or fall sampling is ideal for fields to be planted in the spring. Regardless of when you sample, allow time to mail the samples, receive your report and determine fertilizer requirements.

Taking a soil sample

Soil tests report accuracy and the recommendations that result depend on proper collection, preparation and submission of a soil sample. To take a soil sample you will need:

- soil probe or shovel
- clean plastic pail (do not use galvanized metal pails because these will contaminate the sample for micronutrient analysis, particularly zinc)
- sample bags and boxes, usually available from the soil laboratory
- a pen or marker

Sample each field or individually managed unit separately. Separate large fields, or fields with considerable variation, into smaller sections. This applies even if the areas are too small to fertilize separately. Each sample should represent a field or field section with similar soil texture, topography, organic matter

and crop history. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads, or where lime, manure, compost or crop residues have been piled.

Sample soils using a probe or shovel. Traverse the sampled area in a zigzag pattern to provide a uniform distribution of sampling sites. Take at least 20 soil cores, 15 cm deep, from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken, the more likely the sample will provide a reliable measure of fertility in the field. One sample should not represent more than 10 ha.

Collect the soil in a clean plastic pail. Break up the lumps and mix the soil well, since only about 2 mL of soil from the sample will be used for each analysis. Fill a clean plastic bag with approximately 500 g of soil, place it into the box and forward it for testing. Be sure to clearly mark the sample box with all of the necessary information (sample number, farm name, date, etc.).

Micronutrient deficiencies most often occur in small patches in fields, and problem areas should be sampled separately. When you sample a problem area, be sure to take a comparison sample from an adjacent area without symptoms.

Samples to assess soil nitrogen should be taken following the same sampling method, except they are taken to a depth of 30 cm and must be kept cool or frozen if not submitted immediately.

Interpreting soil test results

The OMAF-accredited soil-testing program provides recommendations for nitrogen, phosphate, potash, magnesium, zinc and manganese fertilizer. It also gives recommendations for the amount and type of lime to be applied, if required. These recommendations are specific to the future crop to be grown, specified on the lab submission form. Crop-specific details may be found on the following pages:

Apples	page 27
Berry crops	page 79
Grapes	page 139
Tender fruit	page 161

These recommendations can produce the highest economic yields when accompanied by good or above-average crop management.

On a soil test report, each nutrient is reported in parts per million (ppm) or milligrams per litre (mg/L) of soil, a letter rating and a fertilizer recommendation (usually kg/ha or lb/ac). The letter rating of the nutrient (i.e.,

high, medium, low, rare or negative response) indicates the likelihood of a profitable response to applied nutrient for the specified crop.

Fertilizer application guidelines depend on the crop. Rates for nitrogen, phosphorus and potassium fertilizers should be adjusted if manure or legume cover crops are incorporated. This information is essential for an optimum fertilizer utilization.

Soil tests from other laboratories

OMAF-accredited soil tests are used to provide accurate fertilizer application guidelines. Make certain that the service you use is accredited. To be accredited, a laboratory must use OMAF-approved testing procedures to demonstrate acceptable analytical precision and accuracy and must also provide the OMAF fertilizer guidelines. Ensure that you ask for the OMAF fertilizer guidelines. Soil tests for nutrient management plans must be completed at OMAF-accredited labs. Soil tests for exchange capacity, aluminum and copper are not accredited by OMAF because they have not been found to contribute to improving fertilizer application guidelines.

Plant tissue analysis

Plant tissue analysis measures the nutrient concentration in plant tissue. It is most useful when combined with visual inspection of the crop and soil conditions, knowledge of past field management and a current soil test to provide information about soil nutrient levels and pH.

For perennial crops, tissue analysis is an important addition to soil tests. Tissue analysis results are compared against established normal ranges for the crop and indicate whether the plant is obtaining adequate nutrients for optimum growth. If soil levels are known to be adequate, low tissue analysis results may indicate there are other possible causes for the nutrient deficiencies. Plant analysis is particularly useful for the evaluation of phosphorus, potassium, magnesium and manganese. It is the main tool for assessing the status of boron, copper, iron and molybdenum, as there is no reliable soil test for these micronutrients.

Sampling

Timing and stage of growth when a sample is collected affects the results of plant analysis. Concentrations of some nutrients vary considerably with the age of the sampled tissue and the date of sampling. Results are difficult to interpret if samples are taken at times other than what is optimal for the crop. See Table 2-2. *Sampling for Tissue Analysis of Fruit Crops*, page 11.

Table 2-2. Sampling for Tissue Analysis of Fruit Crops

Crop	Stage of Growth/Timing	Plant Part Sampled	Approximate Number to Collect
Apple	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Blueberry, Highbush	Late July–early August	Mature mid-shoot leaves of current year growth	100 leaves throughout sampling area
Cherry, Montmorency	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Grape	Early September	Petioles from mature leaves of fruiting canes – remove from leaf immediately	75–200 depending on variety size
Peach	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Pear	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Raspberry	Late July	Fully expanded leaves from fruiting cane	100 throughout sampling area
Strawberry	Fruiting – June Non fruiting – early August	Fully expanded, recently matured leaf – discard petiole immediately	50 leaves throughout sampling area

- Collect tissue samples into labelled paper bags. Plant tissues will rot if stored in plastic bags.
- Avoid collecting damaged leaves or leaves from plants that appear abnormal.
- Plant tissue should be sampled separately from variable areas large enough to sample soil and fertilize separately.
- Avoid contamination of the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.
- Plants suspected of nutrient deficiency should be sampled as soon as a problem appears. Take tissue samples from a problem area and submit a separate sample from an adjacent, non-affected part of the field. Also collect and submit a soil sample from both affected and non-affected areas to aid diagnosis.

Sample preparation

Fresh plant samples should be delivered directly to the laboratory. If they cannot be delivered immediately, they should be dried to prevent spoilage. Samples may be dried in the sun or in an oven at 65°C or less.

Take precautions to prevent contamination with dust or soil. Avoid contact of samples with brass, copper or galvanized (zinc-coated) metal.

Plant analyses may be obtained from several laboratories in Ontario. Refer to Appendix F: *Accredited Soil-Testing Laboratories in Ontario*, page 298. Tissue analysis is not part of the OMAF accreditation program. However, OMAF-accredited labs have the necessary skills and equipment to perform accurate tissue analysis.

Interpretation

Tissue analysis has limitations and expert help is sometimes needed to interpret the results. Tissue analysis does not indicate how much fertilizer is required to correct a deficiency or even whether a deficiency is related to soil fertility problems. Tissue test results in the deficiency range may also be due to factors such as climate, pest pressure or disease, and therefore should be used in conjunction with a soil-testing program. Table 2-3, *Nutrient Concentration Sufficiency Ranges for Fruit Crops*, page 12, shows the range of tissue nutrient concentration that should result in optimum productivity for various fruit crops.

Table 2-3. Nutrient Concentration Sufficiency Ranges for Fruit Crops

Crop	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Iron	Boron	Zinc	Manganese
	%					ppm			
Apples ¹									
Delicious, Crispin	2.2–2.7	0.15–0.4	1.4–2.2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200
Empire, Spy	2.1–2.6	0.15–0.4	1.3–2.1	0.7–1.5	0.25–0.4	25–200	20–60	15–100	20–200
McIntosh, Others	2–2.5	0.15–0.4	1.2–2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200
Berry Crops									
Blueberry, Highbush	1.7–2.3	0.15–0.4	0.36–0.7	0.3–0.8	0.12–0.3	30–100	15–50	10–100	150–500
Raspberry	2–3.5	0.20–0.5	1–2	0.8–2.5	0.25–0.5	25–200	20–60	15–100	20–200
Strawberry	2–3	0.20–0.5	1.5–2.5	0.5–1.5	0.25–0.5	25–200	20–60	15–100	20–200
Grapes (Petioles)									
Vinifera	0.8–1.4	0.15–0.4	1.2–2.3	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Fredonia	0.6–1.2	0.15–0.4	0.8–1.8	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Other	0.7–1.3	0.15–0.4	1–2	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Tender Fruit									
Peach	3.4–4.1	0.15–0.4	2.3–3.5	1–2.5	0.35–0.6	25–200	20–60	15–100	20–200
Pear	2–2.6	0.15–0.4	1.2–2	1–2	0.25–0.5	25–200	20–60	15–100	20–200
Plum	2.4–3.2	0.15–0.4	1.5–3	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200
Cherry, Montmorency	2.2–3	0.15–0.4	1.3–2.5	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200

¹ Leaf nitrogen should be 0.2% higher for apple trees on M.9 or M.26 rootstocks and for all non-bearing trees.

Visual deficiency symptoms

Leaf symptoms can help evaluate some nutrient deficiencies, but have limitations. By the time deficiency symptoms are visible, yield losses may already have incurred. Visual deficiency symptoms are easily confused with other production problems such as pesticide injury, leaf and root diseases, nematodes, insect damage, compaction or air pollution. Suspected visual deficiencies should always be confirmed by tissue analysis. Specific nutrient deficiency symptoms are described in *Apple Nutrition*, page 27; *Berry Crop Nutrition*, page 79; *Grape Nutrition*, page 139; and *Tender Fruit Nutrition*, page 161.

Soil Organic Matter

Soil organic matter helps maintain soil structure, enhances soil moisture-holding capacity, increases the ability of the soil to hold nutrients and improves drainage. Adequate soil organic matter levels can help maintain crop yields and long-term plant health, especially in adverse weather conditions. Many horticultural soils are light-textured and frequently cultivated. The maintenance of organic matter levels in these soils is a challenge but critical to maintain productivity.

To ensure long-term productivity of fruit crops, assess the soil quality of each field before planting and take steps to maintain or improve it. For more information, see OMAF Publication 611, *Soil Fertility Handbook* and Table 2-4. *Optimum Organic Matter Content for Soil Types* on this page.

Table 2-4. Optimum Organic Matter Content for Soil Types

Soil Type	Optimum Organic Matter (%)
Sandy	2–4 +
Sandy loam	3–4 +
Loam	4–5 +
Clay loam	4–5 +
Clay	4–6 +

Source: The Canada-Ontario Environmental Farm Plan Program Workbook, 3rd ed., 2004.

Soil pH and Liming

The pH scale ranges from 0 to 14 and is a measure of the hydrogen ion concentration. A pH value of 7.0 is neutral. Values below 7.0 are acidic. Those above 7.0 are alkaline, also called basic. On mineral soils, most fruit crops grow well in a soil pH range from 6.0 to 7.5.

Blueberries require a range of 4.2 to 5.0. Maintenance of a soil within the appropriate pH range is important. Many crop nutrients, especially micronutrients, become less available at a soil pH above or below the ideal range. At a soil pH less than 5.0, levels of aluminum and manganese may be toxic for sensitive crops.

Raising pH

Soil pH is increased through the broadcast and incorporation of ground limestone into the soil. The amount of lime needed is determined by the soil test results. Table 2-5. *Soil pH and Liming Guidelines for Fruit Crops* on this page shows pH values below which lime is needed, and the target soil pH to which soils should be limed. In Ontario, most crops grow quite well at pH values higher than the target pH.

Table 2-5. Soil pH and Liming Guidelines for Fruit Crops

Fruit crops	Soil pH below which lime is suggested	Target soil pH
Coarse- and Medium-Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All fruit crops not listed below	6.1	6.5
Established tree fruits, grapes	5.6	6.0
Blueberry, cranberry	No lime needed	
Fine-Textured Mineral Soils (clays and clay loams)		
All fruit crops not listed below	5.6	6.0
Established tree fruits, grapes	5.1	5.5
Blueberry, cranberry	No lime needed	
Organic Soils (peats and mucks)		
All fruit crops not listed below	5.1	5.5
Blueberry, cranberry	No lime needed	

Buffer pH

The soil pH measures the amount of acidity in the soil solution, indicating whether liming is necessary for crop production. It does not measure the amount of reserve acidity held on the clay and organic matter particles in the soil, which determines how much lime is needed. Different amounts of reserve acidity will mean that two different soils at the same pH value will need different amounts of lime to raise the pH to the desired level. The reserve acidity is measured in a separate test called the buffer pH. A soil with high reserve acidity will have a low buffer pH and will require considerable lime to raise the pH.

To determine the amount of lime required to reach the target soil pH, use Table 2-6. *Lime Requirements to Correct Soil Acidity* on this page.

Table 2-6. Lime Requirements to Correct Soil Acidity

Buffer pH	Ground Limestone Required (tonne/ha)*			
	Target soil pH = 7.0 ¹	Target soil pH = 6.5 ²	Target soil pH = 6.0 ³	Target soil pH = 5.5 ⁴
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

* Based on Agricultural Index of 75.

¹ Liming to pH 7.0 is recommended only for club-root control on cole crops.

² Add lime if soil pH is below 6.1.

³ Add lime if soil pH is below 5.6.

⁴ Add lime if soil pH is below 5.1.

The lime requirements listed in Table 2-6 are based on the equations in Table 2-7. *Calculation of Lime Required*, on this page, and rounded to the nearest tonne/ha. More exact requirements to adjust soil pH to 7.0 may be calculated from the equations in Table 2-7.

Table 2-7. Calculation of Lime Required

Target Soil pH	Equation*
7.0	Lime (tonne/ha) = $334.5 - 90.79 \text{ pH}_b^{**} + 6.19 \text{ pH}_b^2$
6.5	Lime (tonne/ha) = $291.6 - 80.99 \text{ pH}_b + 5.64 \text{ pH}_b^2$
6.0	Lime (tonne/ha) = $255.4 - 73.15 \text{ pH}_b + 5.26 \text{ pH}_b^2$
5.5	Lime (tonne/ha) = $37.7 - 5.75 \text{ pH}_b$

* Based on lime with an Agricultural Index of 75.

** pH_b = Buffer pH.

Raising the soil pH with limestone

Either calcitic or dolomitic limestone can be applied to raise soil pH. Calcitic limestone consists largely of calcium carbonate, while dolomitic limestone is a mixture of both calcium and magnesium carbonates. The carbonate in the limestone neutralizes the soil acidity.

Use dolomitic limestone on soils with a magnesium soil test of 100 ppm or less. It is particularly important to use dolomitic limestone when the level of potassium is high because high potassium levels make magnesium deficiency more likely. Either calcitic or dolomitic limestone can be used when magnesium test results are greater than 100 ppm and potassium levels are below 250 ppm.

Limestone varies in its effectiveness for raising soil pH depending on its neutralizing value and its fineness rating.

Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

Fineness rating, or particle size, also affects the neutralizing value of limestone. The higher the fineness rating, the more rapidly the limestone raises the soil pH.

The Agricultural Index

The Agricultural Index combines the neutralizing value and the fineness rating of a limestone. It provides a way to compare different limestone sources. Limestone with a high Agricultural Index is applied at a lower rate than limestone with a low index. A limestone's Agricultural Index is determined by the following formula:

$$\text{Agricultural Index} = \frac{\text{neutralizing value} \times \text{fineness rating}}{100}$$

Limestone recommendations from the OMAF-accredited soil tests are based on limestone with an Agricultural Index of 75. When you use a limestone source with a different Agricultural Index, a specific rate of application may be calculated with the following equation:

$$\text{Limestone application rate from soil test} \times \frac{75}{\text{Agricultural Index of the limestone source being used}} = \text{Rate of application of the limestone source being used}$$

For example, if a soil test recommends 9 tonnes/ha of limestone and the limestone source has an Agricultural Index of 90, the application rate should be 7.5 tonnes/ha ($9 \times 75/90 = 7.5$ tonnes/ha).

The Agricultural Index does not provide information about magnesium content.

Effect of tillage depth

The lime application rates presented in Table 2-6, *Lime Requirements to Correct Soil Acidity*, page 13, should raise the pH of the top 15 cm of soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where shallow tillage depths are used, more frequent applications of lower rates are suggested.

Lowering pH

On soils with pH values below 6.5, it is possible to lower the pH (make the soil more acidic) by adding sulphur or ammonium sulphate. This may be desirable for some crops, such as blueberries, but usually will not be suitable for rotation crops. Soil pH cannot be adjusted up or down from year to year. Ammonium sulphate should not be applied at rates of nitrogen higher than those recommended for the current crop. Table 2-8, *Sulphur for Soil Acidification* on this page shows the amount of elemental sulphur required to lower the pH of various soils.

If the soil pH is above 6.5, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulphur or ammonium sulphate required. For more information see OMAF Publication 611, *Soil Fertility Handbook* (Soil Acidification, page 94).

Table 2-8. Sulphur for Soil Acidification

Soil Type	Sulphur Required (kg/ha)	
	For each 1.0 pH unit	For each 0.1 pH unit
Sand	350	35
Sandy loam	750	75
Loam	1,100	110

Nitrogen

Nitrogen is an important element for the growth and development of all plants, and is naturally present in all soils. As soil microbes feed on crop residues and soil organic matter, they release nitrogen into the soil. As soil organic matter levels increase, so do the levels of naturally available nitrogen. Management practices

which maintain and increase soil organic matter will also help to enhance soil fertility and crop productivity. Legumes, such as alfalfa and red clover, can increase soil nitrogen concentrations by capturing atmospheric nitrogen and releasing it slowly into the soil.

Visual nitrogen deficiency symptoms

Nitrogen deficiencies usually first appear on older leaves. These leaves will turn light green or yellow as nitrogen is relocated from older, less productive leaves to the newest growth. Cool temperatures in early spring often cause plants to develop a temporary nitrogen deficiency. This is usually due to poor growing conditions, and not necessarily a lack of nitrogen in the soil.

Nitrogen and the environment

Nitrogen levels in the soil change constantly. Processes like leaching and denitrification result in the loss of nitrogen from the soil. Denitrification occurs when the soil is waterlogged. Anaerobic microbes convert nitrate and ammonia into nitrous oxide. This gas can contribute to air pollution and is approximately 300 times more potent than carbon dioxide as a greenhouse gas.

The nitrate form of nitrogen, while being readily available to plants, moves easily in water through the soil. As a result, it has the potential to pollute groundwater and surface water.

Applying just enough nitrogen to meet the crop's growth requirements greatly reduces the risk of loss to the environment. The potential for nitrogen loss is highest during the late fall and early spring. Applying nitrogen according to the crop's need reduces residual soil nitrogen at the end of the season and leaves little available for losses.

It is important to account for fertilizer, manure and other sources of nitrogen when you assess a crop's fertility requirements. Other management practices to reduce the risk of nitrate losses include:

- use of cover crops
- timing nitrogen applications close to crop nitrogen uptake
- reduction of total nitrogen applications

Sources of nitrogen

Synthetic fertilizer

The most common nitrogen fertilizer sources are outlined in Table 2-9. *Fertilizer Materials: Primary Nutrients* on this page. Generally, all nitrogen sources

are effective in providing a crop with nitrogen. Cost, crop management and ease of application will largely determine the selection of one source over another.

If nitrogen is to be applied early in the spring when soils are below 10°C, using urea may prevent leaching losses. Under these conditions, it takes 3–6 weeks for urea to convert to the plant-available ammonium and nitrate forms. As only nitrate-nitrogen is susceptible to leaching losses, early spring rain will not result in leaching where urea is used as the nitrogen source. By the time the nitrate conversion has occurred, the crop is entering its rapid growth phase and minimal downward percolation of water will make leaching less likely.

Table 2-9. Fertilizer Materials: Primary Nutrients

Nitrogen Materials	Form	% Nitrogen (N)
Ammonium nitrate	dry	34
Ammonium sulphate	dry	20
Calcium ammonium nitrate	dry	27
Calcium nitrate	dry	15.5
Urea	dry	46
Anhydrous ammonia	liquid ¹	82
Urea ammonium nitrate (UAN)	liquid	28–32
Phosphate Materials	Form	% Phosphate (P ₂ O ₅)
Diammonium phosphate (18-46-0)	dry	46
Monoammonium phosphate (11-52-0)	dry	50–52
Single superphosphate	dry	20
Triple superphosphate	dry	46
Ammonium polyphosphate (10-34-0)	liquid	34
Potash Materials	Form	% Potash (K ₂ O)
Muriate of potash	dry	60–62
Potassium nitrate (13-0-44)	dry	44
Sulphate of potash	dry	50
Sulphate of potash magnesia (11% Mg)	dry	22

¹ Liquid under pressure.

Products that modify the release of nitrogen

Slow-release fertilizers have granules that have been coated in sulphur or a polymer to control the release of the nitrogen over an extended period of time. Nitrification inhibitors are added to nitrogen fertilizers to help delay the chemical conversion of urea into the plant-available forms. Depending on the weather conditions, the delayed release of these products may not necessarily coincide with peak nitrogen demand.

Manure nitrogen

In addition to nutrients and micronutrients, manure also supplies valuable organic matter that helps to build and maintain soil structure. Adjust fertilizer rates to account for the nutrients in manure.

During the first growing season after application, 50–60% of the nitrogen in manure is available to the crop. The remaining organic nitrogen becomes available in small, diminishing quantities in successive years. Up to 10% of the total nitrogen in manure can be available for the following year. Where manure is applied regularly to the same field, there may be a significant amount of residual nitrogen available for a crop.

The quantities of nutrients contained in manure can vary greatly. The type of livestock, ration, bedding, added liquids and storage system all affect the final nutrient analysis. Table 2-10, *Average Fertilizer Replacement Values for Manure* on this page provides the approximate amount of crop-available nitrogen in manure. A manure analysis, available from several laboratories in Ontario, provides the most accurate assessment of the nutrients contained in a specific source of manure. Refer to Appendix F: *Accredited Soil-Testing Laboratories in Ontario*, page 298, for a list of laboratories providing this service.

Use manure responsibly

- Avoid the spread of manure on frozen or snow-covered ground.
- Avoid application when the potential for runoff (soil is wet, rain is imminent, etc.) is high.
- Tillage prior to the application of liquid manure will help to break up soil cracks and large pores, and prevent the movement of manure into field tiles or shallow groundwater.
- Inject or incorporate the manure to minimize loss of ammonia to the atmosphere.
- When storing manure, follow guidelines in OMAF Factsheet, *Temporary Field Storage of Solid Manure or Other Agricultural Source Materials*.

Manure and food safety

Fruit can become contaminated in the field if it comes into contact with pathogens that cause human illness. These pathogens may come from manure and manure-based composts. Depending on conditions, these pathogens can survive from 1 to more than 300 days after field application of fresh manure. Pathogens can be reduced to acceptable levels when manure is properly composted. Proper composting means that all parts of the manure pile must heat to 55°C for 3 days to reduce pathogen levels. Fresh or uncomposted manure should not be applied to fields where fruit or vegetable crops will be harvested within 120 days.

Table 2-10. Average Fertilizer Replacement Values for Manure

Nutrient values are based on average analysis for over 3,000 samples.¹ There are large variations in nutrient content between manures, so a manure analysis is your best guide to nutrient availability.

Manure	% Average Dry Matter	Available ² Nitrogen (N)	Available ³ Phosphate (P ₂ O ₅)	Available ⁴ Potash (K ₂ O)
Liquid Manure		kg/1,000 L (lb/1,000 gal)		
Liquid dairy	8.4	1.8 (18)	0.77 (7.7)	2.6 (26)
Liquid hog	3.7	2.7 (27)	1.2 (12)	1.9 (19)
Liquid poultry	10.5	5.8 (58)	2.8 (28)	3.2 (32)
Dry Manure		kg/tonne (lb/ton)		
Solid poultry	55.3	10.5 (21)	11 (22)	13.4 (26.8)
Solid dairy	25	1.8 (3.6)	1.5 (3)	5.2 (10.5)
Composted dairy	38.3	2.9 (5.8)	2.6 (5.2)	11.8 (23.8)
Solid beef	28.4	1.9 (3.8)	2.1 (4.3)	6.1 (12.2)
Sheep	33.8	2.9 (5.9)	2.6 (5.2)	8.3 (16.7)
Horse	37.4	1.3 (2.6)	1.4 (2.8)	4.6 (9.3)

¹ Data from manure analysis provided from Ontario labs collected between 1992 and 2007.

² Nitrogen based on spring application, incorporated within 24 hours. Unincorporated manure will have less N due to ammonia losses.

³ Phosphate from manure or biosolids is assumed to be 40% as available in the year of application as that in commercial fertilizer (another 40% of the phosphorus is available the following year).

⁴ Potassium from manure is assumed to be 90% as available in the year of application as that in commercial fertilizer.

Legumes

Rhizobium bacteria infect the roots of legume crops. These bacteria convert atmospheric nitrogen into inorganic nitrogen. As the legume crop residue decomposes, this nitrogen becomes available for subsequent crops. When fruit crops are planted following alfalfa hay, or a legume cover crop such as red clover, the rate of fertilizer nitrogen should be decreased according to Table 2-11. *Nitrogen Contribution of Plowed-Down Legumes* on this page.

Table 2-11. Nitrogen Contribution of Plowed-Down Legumes

Type of sod	For all crops, deduct from N requirement (kg N/ha)
Less than ½ legume	0
½ to ⅔ legume	55
⅔ or more legume	100
Perennial legumes seeded and plowed the same year	45 ¹
Soybean and field bean residue	0

¹ Applies where the legume stand is thick and over 40 cm high.

Other organic nutrient sources

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. However, before this material can be applied to land, you must have an Environmental Compliance Approval (ECA) issued by the Ontario Ministry of the Environment (MOE) for the site. Rates depend upon the nitrogen content of the material and can be in the range of 25–30 dry tonnes/ha. However, MOE has final approval of the material and the applied rate. Any application restrictions are included as conditions on the ECA.

Biosolids from sewage treatment plants or paper mill waste can be a useful source of nutrients and organic matter. Guidelines for their use are available from OMAF and MOE. An ECA for land application is required and is available from MOE. An analysis of nutrients applied should be given by the applicator to the landowner whenever biosolids are applied. Always consult with your processor, packer or broker before applying municipal sewage biosolids on ground intended for vegetables anywhere in the rotation.

Municipal sewage biosolids must not be applied to tree fruits and grapes within three months of harvest. For small fruit (strawberries, raspberries and blueberries), application may not occur within 15 months of harvest.

Avoid fertilizer burn!

Like all inorganic fertilizers, nitrogen and potash fertilizers are salts. If a germinating seedling or young transplant comes into contact with a concentrated fertilizer band, the tender roots may become seriously damaged. For this reason, it is important to ensure that the correct fertilizer and the appropriate rate are selected for each application.

Urea is an effective, economical source of nitrogen for broadcast applications but it has a relatively high salt index. It is not suitable for use in starter fertilizers or banded applications. If low soil moisture conditions exist at the time of planting, urea burn may occur on coarse sandy loam soils and growers should consider switching to a different nitrogen source. Anhydrous ammonia also has a relatively high salt index. It is an effective source for side-dress applications that must be injected into the soil.

Ensure that starter or transplant fertilizers contain only as much nitrogen as necessary to get the crop started. Fertilizers that contain more than half as much nitrogen as phosphate frequently contain urea and may cause crop damage.

Phosphorus

Like nitrogen, phosphorus is important to photosynthesis and the development of enzymes and protein. It also plays a major role in cell division and the synthesis and transport of sugars and starches.

Soil phosphorus levels across Ontario are variable. Because phosphorus, as orthophosphate, tends to bind to soil particles, leaching through the soil profile is minimal. Many coarse sandy loam soils often contain high phosphorus levels. Soils with a history of regular manure applications have high levels of phosphorus, and fruit crop yield will rarely respond to additional phosphorus fertilizer. Too much phosphorus can induce deficiencies of zinc and iron.

Visual phosphorus deficiency symptoms

Phosphorus deficiency symptoms usually develop on the older leaves first. The leaves develop a purplish-red colour that may be more noticeable on the underside of the leaves. Severe deficiencies may also cause the leaf tips to die back. Cool, wet soil conditions often induce phosphorus deficiencies. During establishment of early-planted fruit crops, use a starter fertilizer to deliver the required phosphorus directly to the root zone.

Phosphorus in the environment

Surface runoff is the main route by which phosphorus leaves the field and contaminates the environment. It can be transported in solution with runoff water or

through its attachment to eroded soil particles. When this water reaches open surface water, streams can become polluted.

Avoid additional phosphorus applications to soils that are rated Rare Response (RR) or No Response (NR). If phosphorus is required to promote early season growth, use low rates applied in a band close to the roots or as a starter fertilizer.

Farmers who are required to complete a nutrient management plan must establish a permanent vegetative buffer adjacent to any surface water, with a minimum width of 3 m, prior to any nutrient application. This practice is highly recommended even in situations where it is not a requirement. The grass will help reduce erosion and act as a natural filter for runoff entering the watercourse.

Where phosphorus soil tests are greater than 30 ppm, use the Phosphorus Index to determine separation distances from surface water sources. The Phosphorus Index uses factors such as field slope, length of slope, soil drainage class and soil texture to determine an appropriate rate and separation distance for phosphorus application from surface water.

For details, see OMAF Factsheet, *Determining the Phosphorus Index for a Field*.

Sources of phosphorus

Mineral fertilizers

The most common phosphate fertilizer sources are outlined in Table 2-9. *Fertilizer Materials: Primary Nutrients*, page 15.

Manure

When properly applied, manure is an excellent, inexpensive phosphorus source. It also supplies the soil with valuable organic matter and micronutrients. Table 2-10. *Average Fertilizer Replacement Values for Manure*, page 16, provides the approximate amount of crop-available phosphorus contained in manure.

Unlike nitrogen, the phosphorus in manure becomes available to crops over a considerable period of time. Regular manure applications may result in a build-up of soil phosphorus, which should be monitored with a soil-testing program.

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Phosphorus application methods

Phosphorus is relatively immobile in the soil; therefore, broadcasting and incorporating any required phosphorus prior to planting perennial fruit crops is crucial. Some phosphorus is often applied at planting in a band or in transplant solution to ensure good vigour of new plantings. On established perennial crops, it can be broadcast on the surface or banded near the roots. Do not rely on fertigation for phosphorus application.

Phosphorus requirements

Use a soil test from an OMAF-accredited lab in conjunction with Table 2-12. *Phosphorus Requirements for Fruit Crops* on this page. For crop-specific details see: *Apple Nutrition*, page 27, *Berry Crop Nutrition*, page 79, *Grape Nutrition*, page 139, and *Tender Fruit Nutrition*, page 161.

Table 2-12. Phosphorus Requirements for Fruit Crops

Soil phosphorus (ppm)*	New plantings of blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	Established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings ¹ of apples, peaches, pears, plums, cherries, grapes
	Phosphate (P ₂ O ₅) required (kg/ha) [response rating]		
0–3	140 [HR]	100 [HR]	80 [HR]
4–5	130 [HR]	90 [HR]	60 [HR]
6–7	120 [HR]	80 [HR]	50 [HR]
8–9	110 [HR]	70 [HR]	40 [MR]
10–12	100 [HR]	70 [HR]	20 [MR]
13–15	90 [HR]	60 [HR]	0 [LR]
16–20	70 [MR]	50 [MR]	0 [LR]
21–25	60 [MR]	40 [MR]	0 [RR]
26–30	50 [MR]	30 [MR]	0 [RR]
31–40	40 [MR]	20 [MR]	0 [RR]
41–50	0 [LR]	0 [RR]	0 [RR]
51–60	0 [RR]	0 [RR]	0 [RR]
61–80	0 [NR]	0 [NR]	0 [NR]
80+	0 [NR]	0 [NR]	0 [NR]

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

* 0.5 M sodium bicarbonate extract test method.

¹ For established tree fruits and grapes, plant analysis is used to estimate requirements.

Potassium

Potassium is an important component of plant cells. It also influences the uptake of water by the roots and plays a role in both respiration and photosynthesis. The sugar and starch content of crops like potatoes and tomatoes may be affected by potassium levels. Most crops require equal amounts of potassium and nitrogen.

Visual potassium deficiency symptoms

Potassium deficiency usually appears on the older leaves first. It can cause yellowing or burning of leaf margins.

Sources of potassium

Mineral fertilizers

The most common potassium sources are outlined in Table 2-9. *Fertilizer Materials: Primary Nutrients*, page 15.

Manure

Manure is an excellent, inexpensive source of potassium. It also supplies the soil with valuable organic matter and micronutrients. Table 2-10. *Average Fertilizer Replacement Values for Manure*, page 16, provides the approximate amount of crop-available potash contained in manure.

Unlike nitrogen, the potassium found in manure can be held by the soil over a considerable period of time. Regular application of manure over time may result in a build-up of potassium which should be monitored with a soil-testing program.

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Potassium application methods

The mobility of potassium fertilizers is limited and falls between that of nitrogen and phosphorus. It is not prone to leaching losses, with the possible exception of very sandy soils low in organic matter. Potash should be broadcast and incorporated prior to planting. In drip irrigation systems, up to half of the potassium requirement can be applied through fertigation after crop establishment. At least half of the potassium should be applied in the spring as a broadcast, band in the drip-line of the crop, or in the herbicide strip. Potassium can be blended with nitrogen and applied in one application.

Foliar applications can be made in grapes and should be considered in dry years when soil uptake is reduced. Foliar application at veraison may improve yield of grapes.

Potassium requirements

Use a soil test from an OMAF-accredited lab in conjunction with Table 2-13. *Potassium Requirements for Fruit Crops* on this page. For crop-specific details see: *Apple Nutrition*, page 27, *Berry Crop Nutrition*, page 79, *Grape Nutrition*, page 139, and *Tender Fruit Nutrition*, page 161.

Excessive potassium applications reduce a crop's ability to take up magnesium from the soil. Where potassium levels are high, magnesium deficiencies are more likely to occur, particularly if magnesium levels are already low.

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance in tree fruits. In apples and tender fruits, do not exceed 3 kg of potash per tree even in cases of severe deficiency.

Do not use muriate of potash (0-0-60) in blueberries, currants and gooseberries due to their sensitivity to chloride.

Table 2-13. Potassium Requirements for Fruit Crops

Soil potassium (ppm) ^a	New or established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings of apples, peaches, pears, plums, cherries ¹	New plantings of grapes ^{1,2}
	Potash (K ₂ O) required (kg/ha) [response rating]		
0-15	130 [HR]	180 [HR]	270 [HR]
16-30	120 [HR]	170 [HR]	270 [HR]
31-45	110 [HR]	160 [HR]	270 [HR]
46-60	100 [HR]	140 [HR]	270 [HR]
61-80	90 [HR]	110 [HR]	270 [HR]
81-100	80 [HR]	70 [MR]	270 [HR]
101-120	70 [MR]	40 [MR]	270 [HR]
121-150	60 [MR]	20 [MR]	270 [MR]
151-180	40 [MR]	0 [LR]	270 [MR]
181-210	0 [LR]	0 [LR]	270 [MR]
211-250	0 [RR]	0 [RR]	270 [LR]
250+	0 [NR]	0 [NR]	270 [LR]

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

^a 1 M ammonium acetate extract test method.

¹ For established tree fruits and grapes, plant analysis is used to estimate requirements.

² Apply only every second year.

Calcium

Calcium is a vital component of cell walls and is involved in the metabolism and formation of the cell nucleus. Calcium pectate in the cell walls provides a physical barrier to disease entry. Calcium does not move readily within the plant.

Calcium deficiencies may cause the growing point to die. It may also cause the blossoms and buds to drop prematurely. However, calcium deficiencies rarely occur in fruit crops grown on soils with a pH of 6.0–7.5. On coarse sandy loam soil, with acidic or low pH, additional soil or foliar calcium may be required. Refer to Table 2-14, *Application Rates for Calcium, Magnesium and Micronutrients* on this page.

Calcium-related disorders may occur in some crops, for example tip burn in strawberries, gummosis in plums, and bitter pit in some apple varieties. Several management practices will reduce the occurrence of

calcium-related disorders. Avoiding over-application of nitrogen will help prevent excessive vegetative growth which can dilute the calcium in the plant. Good soil management practices ensure good root growth, which will promote both water and nutrient uptake. Timely irrigation will help keep calcium moving into the plant.

Foliar applications of calcium can be made to reduce the incidence of bitter pit in apples, gummosis in European plums, stem and bunch breakdown in certain varieties of grapes and various problems in pears. Because of the potential for leaf burn and premature ripening with foliar-applied calcium, only apply if a problem is anticipated. For crop-specific details, see: *Apple Nutrition*, page 27, *Grape Nutrition*, page 139 and *Tender Fruit Nutrition*, page 161. Do not concentrate sprays or leaf burn could occur. To avoid adverse effects on fruit quality and storability, do not apply calcium formulations containing nitrogen beyond the end of July unless correcting a nitrogen deficiency. Consult OMAF Factsheet, *Bitter Pit Control in Apples*.

Table 2-14. Application Rates for Calcium, Magnesium and Micronutrients

A number of micronutrients are available as chelates, with various formulations and nutrient contents. Check the product labels for crop-specific recommendations. The effective use rate for chelated products is the same as for other formulations.

Nutrient	Source	% Nutrient	Other Nutrients	Application	
				Soil	Foliar
Calcium (Ca)	calcitic limestone	22–40	—	✓	—
	calcium chloride	36	64% chloride	✓	✓
	calcium nitrate	19	15.5% nitrogen	✓	✓
	calcium sulphate (gypsum)	23	19% sulphur	✓	—
	dolomitic limestone	16–22	6–13% magnesium	✓	—
	pelletized lime	16–40	0–13% magnesium	✓	—
Magnesium (Mg)	dolomitic limestone	6–13	16–22% calcium	✓	—
	epsom salts	9	13% sulphur	✓	✓
	sulphate of potash magnesia	11	22% potash K ₂ O 20% sulphur	✓	—
Boron (B)	sodium borate	12–21	—	✓	✓
	solubor	20	—	—	✓
	various granular materials	12–15	—	✓	—
Copper (Cu)	copper chelates	5–13	—	—	✓
	copper sulphate	13–25	6.5–12.5% sulphur	✓	—
Iron (Fe)	ferrous sulphate	20	11% sulphur	—	✓
	iron chelates	3–13	—	—	✓
Manganese (Mn)	manganese chelates	5–12	—	—	✓
	manganese sulphate	28–32	16–18% sulphur	—	✓
Molybdenum (Mo)	sodium molybdate	39	—	—	✓
Zinc (Zn)	zinc chelates	9–14	—	—	✓
	zinc oxysulphate	8–36	—	✓	—
	zinc sulphate	36	17% sulphur	✓	✓

Table 2-15. Magnesium Soil Test Ratings for Fruit Crops

Soil Magnesium* (ppm Mg)	Rating	Recommendation
Below 20	HR	Magnesium (Mg) should be applied for all crops. If pH is below 6.5, apply dolomitic limestone. At higher pH values, apply 30 kg soluble Mg/ha. Potash applications in excess of those recommended by soil test will increase the probability of magnesium deficiency.
20–39	MR	Magnesium is not required unless potassium (K) soil test is above 250 ppm. If soil test K is above 250 ppm and pH is below 6.5, apply dolomitic limestone. At higher pH values with K above 250 ppm, apply 30 kg soluble Mg/ha.
40–100	LR	If limestone is required, use dolomitic.
100+	NR	If limestone is required, either dolomitic or calcitic may be used.

HR = High response. MR = Medium response. LR = Low response. NR = No response to applied nutrient.

* 1 M ammonium acetate extract.

Magnesium

Magnesium is an essential part of chlorophyll and aids in the formation of sugars, oils and fats.

Magnesium is mobile within the plant. Deficiencies usually appear on the older leaves first as it is translocated to the younger leaves. The leaf tissue between the veins turns yellow, while the veins remain green. Severe deficiencies will cause the leaf margins to curl. In apples, magnesium deficiency can cause premature fruit drop, especially with McIntosh. A foliar spray will correct magnesium deficiency in the current year only, and should be combined with soil application for a longer term solution.

In conjunction with an OMAF-accredited magnesium soil test, consult Table 2-15, *Magnesium Soil Test Ratings for Fruit Crops* on this page.

Excessive potassium applications can induce a magnesium deficiency; therefore avoid using high rates of potash on soils with a low magnesium rating.

Micronutrients

Micronutrients include boron, copper, iron, manganese, molybdenum and zinc. Plants use these elements in much smaller amounts than macronutrients (nitrogen, phosphorus, potassium, calcium and magnesium). Because such small quantities are required, routine application is generally an unnecessary expense. However, micronutrients are crucial to growth and deficiencies must be corrected.

Micronutrients are usually found in much lower levels in the soil than macronutrients. Soil pH, organic matter, clay and mineral content can strongly influence

micronutrient availability. This makes soil tests for estimating micronutrient availability less reliable than those for the primary nutrients.

Which to choose: soil or foliar fertilizers?

Both soil and foliar fertilizers play a role in fruit crop production. The macronutrients are required in relatively high amounts for crop growth. As a result, soil application is almost always the most efficient and economical method of getting these nutrients into the plant. Foliar uptake occurs through the leaf's cuticle and the stomata. The amount of nutrients that can enter the plant through these means is quite limited. Higher application rates may lead to crop injury.

Since micronutrients are required in much lower quantities, they can often be efficiently delivered through foliar applications, especially when soil conditions limit micronutrient availability. If a micronutrient deficiency is found, foliar application is the quickest way of addressing it. This can be followed with a soil application to prevent a recurrence, depending on the micronutrient and the soil pH.

Do not apply micronutrients to fruit crops unless a deficiency is identified. Apply only the deficient nutrient in sufficient quantities to correct the problem. The range between deficiency and toxicity with micronutrients can be narrow.

Use caution when you apply mixtures of several micronutrients, as crop injury may occur. Always follow the product label. Do not combine micronutrients with insecticides, fungicides or herbicides unless there is information from the manufacturers that indicates the components are compatible. Many chelated micronutrients will consolidate in the spray tank if mixed with pesticides. Use caution when applying micronutrients through fertigation systems. Certain micronutrient blends may plug the emitters.

Foliar-applied nutrient uptake can be improved through the timing of the application and the use of surfactants. Younger leaves generally have a less well-developed cuticle and are able to take up more of the nutrient. Early morning applications may favour foliar uptake, and drought stress that results in a thicker cuticle may hinder uptake. Avoid the application of foliar nutrients during the heat of the day when leaves will dry quickly. Ensure good leaf coverage, particularly on the underside.

If a micronutrient is required, refer to Table 2-14.

Application Rates for Calcium, Magnesium and Micronutrients, page 20, and consult the manufacturer's label for information on rates, timing and recommendations to minimize injury.

Boron

Boron plays an important role in the structure of cell walls, fruit set and seed development, as well as protein and carbohydrate metabolism.

Boron deficiency is most likely to be found on alkaline soils or sandy knolls. Symptoms vary widely between crops. Apples may exhibit internal breakdown and premature drop of highly coloured fruit. Boron toxicity may occur when sensitive crops are planted in a rotation where boron has been applied or over-applied.

There is no OMAF-accredited boron soil test. Some soil test reports provide a soil boron value; however, soil levels are often less than 1 ppm, making it very difficult to get an accurate measurement. To correct deficiency, fertilizer manufacturers may mix boron sources with other fertilizers to be applied. Boron can also be foliar-applied for faster results.

Some crops are very sensitive to boron deficiencies, even at low levels. A soil pH between 5.0 and 7.0 provides the best conditions for boron uptake. Boron deficiencies are more likely to occur on soils with low organic matter and on exposed or eroded subsoils. Boron availability decreases during periods of drought.

Copper

Copper plays a role in chlorophyll production. It may also have a role in the suppression of some diseases.

Copper deficiency is rare on mineral soils, except perhaps very sandy soils.

Because soil tests for copper are unreliable, there is no OMAF-accredited copper soil test. Plant tissue analysis is a more useful tool.

Copper sulphate may injure leaves.

Iron

Iron is needed for chlorophyll formation, plant respiration and the formation of some proteins.

Iron deficiency, also called lime-induced chlorosis, is rare in Ontario. Symptoms appear on the young leaves first. Leaves turn yellow between the veins, but the veins will remain green except in extreme cases. Often symptoms are seen in only one area of the plant. Factors associated with iron deficiency include soils with high lime content (and therefore high pH), and gross imbalances with other micronutrients like molybdenum, copper or manganese.

An iron soil test does not correlate well with plant uptake or fertilizer response in Ontario. Consequently, there is no OMAF-accredited iron soil test. Plant analysis is a much more reliable indicator of iron availability. Iron deficiency is easily corrected with the foliar application of iron chelates, whereas soil application is not generally effective.

Manganese

Manganese is involved in photosynthesis and chlorophyll production. It helps activate enzymes involved in the distribution of growth regulators within the plant.

Manganese deficiency causes yellowing between veins of young leaves. Leaves gradually turn pale green with darker green next to the veins. Manganese toxicity can occur on soils with a low pH. It causes brown spots or yellow mottled areas near leaf tips and along the leaf margins and usually develops on older leaves. Brown spots may also develop on veins, petioles and stems.

The OMAF-accredited manganese soil test uses a manganese availability index. This index evaluates manganese availability based on soil manganese level and soil pH.

Soil-applied manganese may be useful in acidic, sandy soils. In soils with a pH greater than 6.5, soil-applied manganese will be unavailable to the plant. On alkaline soils, banded applications are often more effective than broadcast. Foliar-applied manganese is generally more effective where a manganese deficiency has been confirmed. If a deficiency is confirmed, apply foliar sprays when the plants are about one-third grown or sooner. Two or more sprays may be necessary at 10-day intervals.

Manganese availability is greatest at a soil pH of 5.0 to 6.5. It is important not to add more limestone than is needed to correct soil acidity. High organic matter levels

decrease manganese availability. Foliar applications may be required for crops grown on muck soils.

Zinc

Zinc is important in early plant growth and in seed formation. It also plays a role in chlorophyll and carbohydrate production.

Zinc is relatively immobile within the plant. Deficiency symptoms appear first on younger leaves. Young leaves become mottled and show interveinal chlorosis, striping or banding. In advanced stages in tree fruits, small, narrow terminal leaves are arranged in whorls. This results in the typical "rosette" and "little leaf" description for zinc deficiency symptoms. Use leaf and soil analysis to test for zinc deficiency.

The OMAF-accredited zinc soil test is reported as a zinc index value, which estimates availability based on soil zinc level and soil pH. Zinc deficiency can be prevented by the application of zinc fertilizer to the soil at a rate of 4 kg of zinc/ha. Broadcasting up to 14 kg of zinc/ha will correct a deficiency for three years. No more than 4 kg zinc/ha should be banded. Early in the growing season, foliar sprays can be used to correct a deficiency after the symptoms have appeared.

Zinc deficiencies are most often seen on sandy soils with high pH levels. Heavily eroded knolls may also have deficiency problems. Large applications of phosphorus may aggravate zinc deficiencies. Livestock manure is often an excellent source of zinc.

Cover Crops

Cover crops play a major role in soil management by providing ground cover to reduce erosion and by adding organic matter to improve or maintain the soil. There is growing interest in the use of cover crops for disease and pest suppression to replace or supplement chemical controls. Cover crops have a wide variety of suitable planting dates. However, plant cover crops immediately after harvest to get the most soil improvement benefits from the cover crop investment. While broadcast application and incorporation of cover crop seed works well to establish cover crops, direct seeding or drilling will ensure faster and more even establishment.

Knowing what you want to achieve with a cover crop will help you select the best one for the job. See Table 2-16. *Selecting a Cover Crop*, page 24, and Table 2-17. *Characteristics of Cover Crops*, page 25. Cover crops can be divided into three groups based upon plant types: grasses, legumes and non-legume broadleaves.

Grasses

Grasses have fine, fibrous root systems that are well-suited to holding soil in place and improving soil structure. Grass species suitable for cover crops are fast growing and relatively easy to kill (chemically, mechanically or by winter temperatures). Grasses do not fix nitrogen from the atmosphere, but they can scavenge large quantities of residual nitrogen left in the field after harvest. Wind strips are usually created from overwintering grass cover crops.

Spring cereals

Spring cereals are well-suited for late summer and early fall plantings. Under good growing conditions, spring cereals, like oats and barley, produce the greatest amount of crop biomass, and provide good ground cover. Once well-established, spring cereals are relatively tolerant of frost. Do not attempt to establish spring cereals later than mid-September, however, as the growth will be limited.

Winter cereals

Winter cereals are highly versatile cover crops. They can be planted in summer and will tiller and thicken due to their need for a cold treatment before flowering. Cereals such as winter wheat and rye can also be planted in fall for soil cover. Winter cereals generally overwinter well, providing winter and spring erosion protection. These grasses can be used to create spring wind barriers or residue mulch, or they can be killed early with herbicide to minimize residue cover at planting.

Warm-season grasses

Warm-season grasses like sorghum and millet are best suited for planting into the warmer soils of late June, July and early August. They are very sensitive to frost. Root growth is extensive and the top growth lush. Be prepared to mow these grasses to keep stalks tender and prevent heading. Do not mow closer than 15 cm to ensure regrowth. Nitrogen may be needed to achieve optimal growth.

Legumes

Legume cover crops can fix nitrogen from the air. They then supply nitrogen to the succeeding crop, protect the soil from erosion and add organic matter. The amount of nitrogen fixed varies depending upon species, stand density and the length of growth. Generally, more top growth indicates that more nitrogen is fixed. Ontario research has suggested that legume cover crops, such as red clover, are also effective at scavenging residual nitrogen from the soil.

Nitrogen release from legumes can be inconsistent. Account for this when calculating crop fertilizer needs. Excess nitrogen release late in the season could lead to excessive vegetative growth in fruit crops.

Some legume species, such as alfalfa or red clover, have aggressive tap roots that can break up subsoil compaction, but this requires more than one season's growth.

Non-legume broadleaves

These broadleaf crops cannot fix nitrogen out of the air but they may absorb large quantities from the soil. Growth will be poor if soil nitrogen levels are low or if compaction is severe. Most of these crops are not winter-hardy, so additional control measures are not normally required. Do not allow these crops to go to seed, as the volunteer seedlings can become a significant weed problem.

Cover crop mixtures

There is growing interest in cover crop mixtures from simple two-species mixes, such as oats and cover crop radish, to more complex mixtures. Mixtures support greater diversity and appear to achieve greater plant growth through synergy.

New and emerging cover crops

Every year new crops are evaluated as cover crops. Often these species are from different parts of the world and may not be well-adapted to Ontario growing conditions. For more information on new and well-known cover crop species, see the soil management section of the OMAF website at www.ontario.ca/crops or look at the regional pages and the Cover Crop Decision Tool from the Midwest Cover Crop Council at www.mccc.msu.edu.

Table 2-16. Selecting a Cover Crop

Function of the Cover Crop	Best Choice for Cover Crop
Nitrogen production	• Red clover or vetch
Nitrogen scavenging	• Fall uptake – oilseed radish and other brassicas, oats • Winter/spring uptake – rye, winter wheat
Weed suppression	• Oilseed radish and other brassicas • Winter rye, sorghum sudan • Buckwheat
Nematode suppression ¹	• Mustard – Caliente, Cutlass, Forge • Sudans/sorghums – Sordan 79, Trudan 8 • Pearl millet – CFPM 101 • Marigold – Crackerjack, Creole • Oilseed radish – Adagio, Colonel
Soil structure building	• Oats, overwintered winter rye • Diverse cover crop mixtures
Compaction reduction	• Alfalfa, sweet clover
Biomass return to soil	• Fall – oats, oilseed radish, diverse cover crop mixtures • Summer – millets, sorghum sudan
Erosion protection (wind or water)	• Winter rye, winter wheat • Any well-established cover crop, e.g., ryegrass

¹ Nematode suppression is specific to the variety of cover crop, the species of nematode and the management of the cover crop materials.

Table 2-17. Characteristics of Cover Crops

Species	Seeding Rate (kg/ha) ¹	Seeding Time	Min. Germination Temp. °C (°F)	Nitrogen Fixed (F) or Scavenged (S) ²	Overwintering Characteristics	Building Soil Structure	Weed Suppression	Nematode Rating ³ Lesion/Rootknot	Growth Rate/Establishment	Root Type
Grasses										
Spring cereals	50–125	mid-Aug–Sept	9 (48)	S	killed by heavy frost	good	good	+/-	very fast	fibrous
Winter wheat	100–130	Sept–Oct	3 (38)	S	overwinters very well	good	good	+/nh	fast	fibrous
Winter rye	100–125	Sept–Oct	1 (34)	S	overwinters very well	very good	very good	+ ⁴ /nh	very fast	fibrous
Sorghum sudan	30–50	Jun–Aug	18 (65)	S	killed by frost	good	good/fair	nh/-	very fast	coarse fibrous
Pearl millet	4–9	Jun–Aug	18 (65)	S	killed by frost	good	good/fair	nh/nh	fast	coarse fibrous
Ryegrass	12–18	Apr–May or Aug–early Sept	4.5 (40)	S	annual, Italian often survive; perennial overwinters	very good	fair/poor	-/-	slow	dense fibrous
Broadleaves – Legumes⁵										
Hairy vetch	20–30	Aug	15.6 (60)	F/S	overwinters	good	fair/poor	+++	slow	tap with secondary fibrous
Red clover	8–10	Mar–Apr	5 (41)	F/S	overwinters	good	fair	++++	slow	weak tap/fibrous
Sweet clover	8–10	Mar–Apr	5.5 (42)	F/S	overwinters	good	fair	-/-	slow	strong tap
Field peas	40–100	Jul–early Sept	5 (41)	F/S	killed by heavy frost	poor	good/fair	-/-	fast	weak tap/fibrous
Broadleaves – Non-Legume										
Buckwheat	50–60	Jun–Aug	10 (50)	S	killed by first frost	poor	very good	+++ /nh	fast	weak tap/fibrous
Oilseed radish ⁶	6–14	mid-Aug–early Sept	7 (45)	S	killed by heavy frost	fair	very good	-/-	fast	moderate tap
Other Brassicas ⁶ , i.e., mustard, forage radish	varies with species	mid-Aug–early Sept	5–7 (41–45)	S	species dependent, many killed by heavy frost	fair	very good	-/-	fast	moderate tap

Nematode Rating Codes: - = Poor. + = Ability to host. nh = Non-hosts.

Cover crop seeding rates can vary greatly depending upon the goals for the cover crop, soil type and need or tolerance for crop residues.

¹ 100 kg/ha = 90 lb/ac.

² Oilseed radish, buckwheat and the grasses do not fix nitrogen from the air but are scavengers of nitrogen from soil and manure applications.

³ Varietal differences in cover crop species may affect nematode reaction or lead to higher nematode populations. Proper variety selection is needed to ensure this cover crop is a non-host.

⁴ Rye whole-season rating would be higher.

⁵ Some diseases caused by *Pythium* and *Phytophthora* can be more severe after legume cover cropping.

⁶ Oilseed radish and other Brassica cover crops can be used as biofumigants when managed appropriately. The plant residues can be toxic or allelopathic to subsequent crops if the following crop is planted too closely after incorporation of the cover crop. Allow the cover crop residues to break down or desiccate before planting the next crop.

SOIL MANAGEMENT

3. Apples

Apple Nutrition

Test the soil one year in advance of planting apple trees, or two years before planting if pH adjustment may be necessary. The best time to thoroughly incorporate organic matter, phosphorus, potassium and lime is before planting. These materials are required to optimize orchard productivity but do not move readily through the soil profile.

Manure for Orchards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and many macro- and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for several years. Adjust additional organic and inorganic nitrogen applications accordingly. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth and delayed cold-hardening of the woody tissue, which makes trees more susceptible to winter injury.

Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid), or 35 tonnes/ha of hog manure (65 m³ liquid). Since the nutrient content of manure varies greatly, have it tested for nutrients before application. Broadcast manure at moderate rates and work into the soil in late fall or early spring before planting. Do not put manure around newly planted trees because of potential winter injury. Reduce the rate of nitrogen, phosphorus and potassium fertilizers applied to adjust for the nutrients supplied by manure. Table 2-10. *Average Fertilizer*

Replacement Values for Manure, page 16 shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen* and *Use manure responsibly*, page 16.

pH Requirements

The pH of a soil is a measure of its acidity and can affect nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime at suggested rates prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, page 12.

In established orchards, sample soil in the tree row every three years to ensure the pH is satisfactory. If the pH is below 5.1 on clay loam soils or 5.6 on sandy soils, apply lime to the sod cover in the fall or before spring cultivation. The pH will not change immediately because lime moves and reacts slowly in the soil.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient needs. The nutrient levels in these plant tissues most accurately reflect the tree's uptake of nutrients. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests, see *Plant tissue analysis*, page 10.

Many orchard conditions affect nutrient uptake. Consequently, nutrient levels vary slightly each year depending on the season. To obtain optimum growth

Table 3-1. Foliar Nutrient Sufficiency Range of Apple*

Variety	Nitrogen ¹	Phosphorus	Potassium	Calcium	Magnesium	Iron	Boron	Zinc	Manganese
	%					ppm			
Delicious, Mutsu/Crispin	2.2–2.7	0.15–0.4	1.4–2.2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200
Empire, Spy	2.1–2.6	0.15–0.4	1.3–2.1	0.7–1.5	0.25–0.4	25–200	20–60	15–100	20–200
McIntosh, others	2–2.5	0.15–0.4	1.2–2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200

* Mid-shoot leaves taken in last 2 weeks of July from mature trees.

¹ Leaf nitrogen in non-bearing trees should be 0.2% higher. Leaf nitrogen on M.9 or M.26 rootstocks should be 0.2% higher.

and fruit quality, all nutrients must be present in sufficient concentrations, as indicated in Table 3-1. *Foliar Nutrient Sufficiency Range of Apple*, page 27.

For leaf analysis to be effective, sample the same trees each year and adjust the fertilizer program based on this leaf analysis. Fertilizer recommendations are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required.

Fertilizer for Apples

Fertilizer for non-bearing apples

The best time to effectively incorporate nutrients such as potassium, phosphorus, boron and lime into the soil is prior to planting the orchard. Adequate soil nutrient levels are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 3-2. *Phosphorus and Potassium Soil Requirements Before Planting Apples* on this page provides information on fertilizer rates prior to planting.

In the early years, before new trees bear their first crop, an annual early spring application of nitrogen and potash is usually required. For suggested rates, refer to Table 3-3. *Actual Nitrogen Requirements based on Tree Density and Age*, page 29, and Table 3-4. *Muriate of Potash Requirements based on Tree Density and Age*, page 30.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk. Applying too close may result in injury. If the soil was prepared properly through deep cultivation and the addition of organic matter, such as manure, there should be an adequate supply of other nutrients to sustain the orchard in its juvenile years.

On coarse-textured, low-nutrient soils, it may help to use a starter solution at planting time, such as 10-52-10 or 20-20-20.

High nitrogen application rates and soil levels can result in excessive growth and delay dormancy. Cover crops are strongly recommended to check late-season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and will check the tree growth.

Table 3-2. Phosphorus and Potassium Soil Requirements Before Planting Apples*

Phosphorus		Potassium	
Soil test (ppm P)	Phosphates (P ₂ O ₅) required kg/ha [response]	Soil test (ppm K)	Potash (K ₂ O) required kg/ha [response]
0–3	80 [HR]	0–15	180 [HR]
4–5	60 [HR]	16–30	170 [HR]
6–7	50 [HR]	31–45	160 [HR]
8–9	40 [MR]	46–60	140 [HR]
10–12	20 [MR]	61–80	110 [HR]
13–15	0 [LR]	81–100	70 [MR]
16–20	0 [LR]	101–120	40 [MR]
21–25	0 [RR]	121–150	20 [MR]
26–30	0 [RR]	151–180	0 [LR]
31–40	0 [RR]	181–210	0 [LR]
41–50	0 [RR]	211–250	0 [RR]
51–60	0 [RR]	250+	0 [NR]
61–80	0 [NR]		
80+	0 [NR]		

* For established apple trees, use leaf analysis to estimate requirements of nitrogen, phosphorus and potassium.

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

Fertilizer for bearing apples

Most bearing orchards require annual nitrogen application. Use a soil test to determine potassium requirements. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, including growth, fruit bud formation, fruit set and fruit size. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates.

Tree growth, foliage colour, fruit quality such as colour and storability, and nutrient balance in leaves and soil are also important considerations for determining nitrogen rates. Several forms of nitrogen are available, but ammonium nitrate (34-0-0) or calcium ammonium

Table 3-3. Actual Nitrogen Requirements based on Tree Density and Age¹

Reduce nitrogen rate by half if orchard is cultivated without sod between tree rows. Do not exceed 200 kg of actual nitrogen per ha per season regardless of number of trees per ha.

These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc. The best way to determine nitrogen requirements is with regular leaf analysis.

Tree age (years)	Trees per ha (trees per ac)										
	600 (240)	800 (320)	1,000 (400)	1,200 (480)	1,400 (560)	1,600 (640)	1,800 (720)	2,000 (800)	2,200 (880)	2,400 (960)	2,600 (1,040)
	Actual nitrogen per tree (g)										
1	30	30	30	30	30	30	30	30	30	30	30
2	60	60	60	60	60	60	60	60	60	60	60
3	90	90	90	*	*	*	*	*	*	*	*
4	120	120	120	*	*	*	*	*	*	*	*
5	150	150	150	*	*	*	*	*	*	*	*
6	180	170	168	*	*	*	*	*	*	*	*
7	206	190	186	*	*	*	*	*	*	*	*
8	232	210	204	*	*	*	*	*	*	*	*
9	258	230	*	*	*	*	*	*	*	*	*
10	284	250	*	*	*	*	*	*	*	*	*
11	310	*	*	*	*	*	*	*	*	*	*
12	336	*	*	*	*	*	*	*	*	*	*
13 or older	*	*	*	*	*	*	*	*	*	*	*

* (shaded areas) = Use leaf analysis to determine nitrogen needs.

¹ Grown in sod.

nitrate (27-0-0) are the most economical. If you use blended fertilizers, request ammonium nitrate as the nitrogen source. Do not apply urea (46-0-0) to orchards with sod between the rows because urea must be incorporated to prevent loss of ammonia nitrogen to the air.

Nitrogen rates

Given the variety of orchard systems, rootstocks, cultivars and soil types, the exact amount of nitrogen to apply varies. Use leaf analysis to evaluate the nitrogen needs of specific plantings. Table 3-3. *Actual Nitrogen Requirements based on Tree Density and Age* on this page is an estimate of possible nitrogen requirements. When the tree canopy covers the available space, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Orchards grown under clean cultivation require about half the nitrogen required by orchards grown in sod.

- If late winter or early spring pruning is to be severe, reduce or eliminate nitrogen application for that year.
- Do not apply late or excessive amounts of nitrogen, as this will affect fruit colour and quality. Available nitrogen late in the season may affect hardening off and increase the possibility of winter injury.

- In cultivated orchards, use cover crops to help lower the soil nitrogen level in the latter part of the season. Cover crops, such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and limit tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds will take up extra nitrogen, which helps harden off trees and improve fruit quality.
- For all apple cultivars, do not exceed the maximum rates of 200 kg actual nitrogen per ha per year, even in the case of a severe deficiency.

Nitrogen placement and timing

Apply nitrogen fertilizer in early April. In cultivated orchards, broadcast nitrogen under the tree canopy. In orchards with sod between the rows, place the nitrogen in a band under the drip line or in the herbicide strip.

Foliar application of nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples when weather or crop conditions resulted in the need for additional nitrogen at a critical time.

Table 3-4. Muriate of Potash Requirements based on Tree Density and Age¹

Do not exceed 800 kg of 0-0-60 per ha per season regardless of number of trees per ha. These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

Tree age (years)	Trees per ha (trees per ac)											
	<500 (<200)	600 (240)	800 (320)	1,000 (400)	1,200 (480)	1,400 (560)	1,600 (640)	1,800 (720)	2,000 (800)	2,200 (880)	2,400 (960)	2,600 (1,040)
	Muriate of potash per 2.5 cm trunk diameter (g)											
1	80	80	80	80	80	80	80	80	80	80	80	80
2	80	80	80	80	80	80	80	80	80	80	80	80
3	80	80	80	80	*	*	*	*	*	*	*	*
4	80	80	80	80	*	*	*	*	*	*	*	*
5	80	80	80	80	*	*	*	*	*	*	*	*
6	80	80	80	80	*	*	*	*	*	*	*	*
7	80	70	63	52	*	*	*	*	*	*	*	*
8	80	70	63	52	*	*	*	*	*	*	*	*
9	80	70	63	52	*	*	*	*	*	*	*	*
10	80	70	63	52	*	*	*	*	*	*	*	*

* (shaded areas) = Use leaf analysis to determine nitrogen needs.

¹ Grown in sod.

On apples, use no more than 2.7 kg N/1,000 L water (6 kg urea) and apply at least 2,000 L/ha starting 7–10 days after petal fall. Make no more than 3 applications, about 10 days apart. Do not apply later than the end of July or fruit quality and winter survival of the tree could be adversely affected.

Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With a few exceptions, the level of phosphorus in Ontario soils is generally adequate. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if this nutrient needs to be added to the sod cover. If indicated, apply phosphorus before planting so it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12 and 20 ppm are considered adequate for tree establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. Because an excess of potassium can lead to a deficiency of magnesium (Mg), avoid unnecessary potassium applications. Potassium soil test values between 120 and 150 ppm are considered adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use the approximate rates in Table 3-4. *Muriate of Potash Requirements based on Tree Density and Age* on this page.

Apply no more than 3 kg of K₂O (5 kg of muriate of potash) per mature standard apple tree in a year, regardless of how severe the potassium deficiency. When fertilizing trees on dwarfing rootstocks, consult Table 3-4. *Muriate of Potash Requirements based on Tree Density and Age* on this page for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide to determine potassium requirements.

Placement and timing

The best time to apply potassium, either separately or combined with nitrogen, is the spring. While some growers prefer the fall because of time constraints in the spring, leaching over winter may cause potassium loss. For this reason, apply in spring if possible.

In orchards with sod between the rows, apply potash in a band around the drip line or in the herbicide strip.

Calcium (Ca)

A lack of calcium is associated with fruit problems such as bitter pit of apple.

Foliar application of calcium to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem, apply 4 foliar sprays 2 weeks apart, beginning in mid-July. See Table 3-5. *Calcium Foliar Sprays*, page 31. Where more calcium

Table 3-5. Calcium Foliar Sprays

Timing	Product	Rate	Notes
4 sprays spaced 2 weeks apart beginning in mid-July. Additional sprays can be applied up to harvest.	Calcium chloride* (77% flakes)	5 kg/1,000 L water	Do not use on McIntosh or Idared. Wet tree to point of runoff. For pesticide compatibility, consult labels.
	Calcium nitrate	9 kg/1,000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility, consult labels.
	Other formulations including chelates		Consult label.

* When using calcium chloride, mix required calcium in a pail of water first to be sure all product is dissolved before adding slurry to spray tank.

is required, make additional applications by either beginning earlier around mid-June or by continuing until harvest.

Calcium advances fruit maturity, so be prepared to adjust the timing of harvest as a result of calcium foliar sprays.

Calcium sprays must contact the fruit for uptake to be effective. Therefore, water volumes capable of wetting the entire tree are required. High concentrations of calcium can cause foliar burn. If applied too close to harvest, some formulations of calcium chloride (CaCl_2) have resulted in poor fruit finish.

Do not exceed more than 5 kg CaCl_2 (77% flakes)/1,000 L of water in mid-July and no more than 7 kg/1,000 L of water for applications at or beyond mid-August. Applying calcium formulations that contain nitrogen after the end of July may reduce fruit quality and storability. For all formulations, consult the label directions for application rates and pesticide compatibility. The product used is not as important as the total amount of actual calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays.

Calcium sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh failed to show an advantage in fruit firmness and storage quality when fruit was stored in regular controlled atmosphere storage for 5½ months. Limit applications of calcium to fruit that has a known deficiency and/or is prone to bitter pit or cork spot. For more information on calcium disorders, consult OMAF Factsheet, *Bitter Pit Control in Apples*.

Magnesium (Mg)

Magnesium soil test values between 100 and 250 ppm are considered adequate when fruit trees are to be planted. Magnesium deficiency has become more evident in orchards, particularly where high rates of potash have been used and can lead to premature drop of fruit at harvest, especially with McIntosh. As magnesium is a part of the chlorophyll molecule, magnesium-deficient trees have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium requirements.

Foliar sprays of magnesium effectively correct this deficiency only for the year of application. See Table 3-6. *Magnesium Foliar Sprays*, page 32.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulphate, so apply magnesium sulphate separately. Check manufacturer's label about mixing magnesium chelates with pesticides. Use chelates recommended for foliar sprays.

For long-term corrections, soil applications of magnesium are required. However, crop response is not usually immediate. On some soil types a single, early spring application of soil-applied magnesium is not effective. A second or third application the next spring may be needed before the magnesium level in the tree improves. To avoid early fruit drop in this waiting period, apply foliar magnesium sprays for the first two years, in addition to soil applications.

Use dolomitic limestone to supply magnesium and raise the soil pH on acidic soils.

Where lime is not required, apply sulphate of potash magnesia (0-0-22-11% Mg-22% S) at 5–7 kg per mature standard tree or 3–4 kg per mature dwarf tree. This is a granular fertilizer that contains approximately 22% potash and 11% magnesium. Apply this material in early spring in a band under the tree drip line. It contains potassium (K) and the rate of application

Table 3-6. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulphate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label.	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

depends on potash needs. Other sources of magnesium also work well as a soil application. If magnesium is blended with the fertilizer, apply at least 80 kg of available magnesium per ha when the fertilizer is spread.

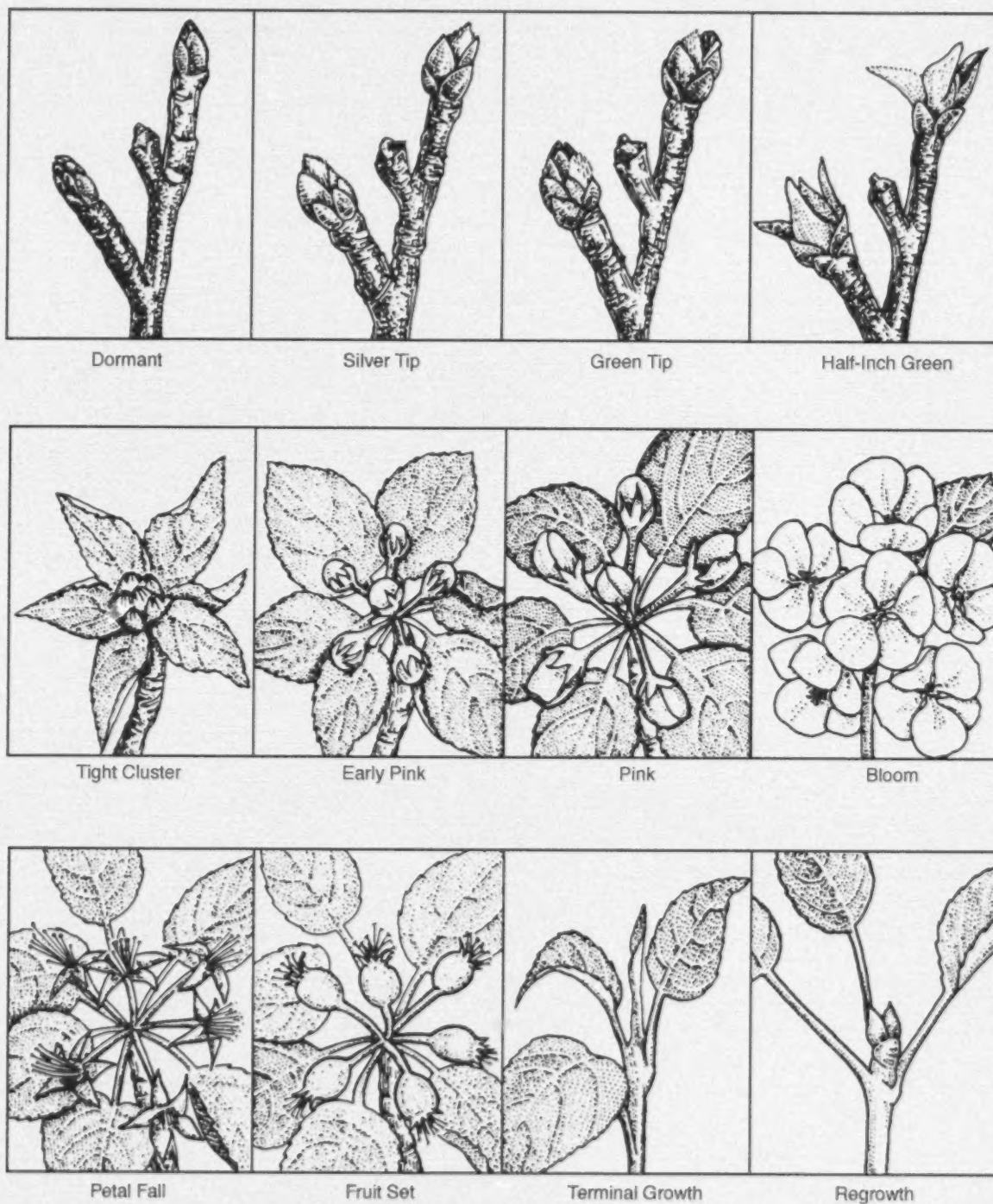
Warning: Apply nutrient sprays according to recommended rates on the product label. Do not spray at temperatures above 25°C.

Micronutrients for Apples

Deficiencies of micronutrients are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese and iron appear occasionally, particularly in alkaline or high pH soils.

The desirable range for micronutrients is very small. More damage is possible with excess amounts than with deficiencies. Do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms. Apply only the nutrient that is deficient in sufficient quantities to correct the problem. For more information on micronutrients in apples, see *Micronutrients*, page 21.

Figure 3-1. Apple Growth Stages



Apple Calendar

Read the product label and follow all safety precautions.

Unless specified on the product label, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, or if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 3-7. *Products Used on Apples*, page 50.

Resistance Management

To delay development of resistance to fungicides, insecticides, and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Use products containing only one chemical family no more than twice per season.
- Use sufficient water to provide thorough coverage.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (codling moth, oriental fruit moth), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with rapidly building and overlapping generations (mites, aphids), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to apples during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant			
San Jose scale	• Superior 70 Oil (NC)	20 L/1,000 L water	Oil may cause bark injury on Red Delicious, Empire and Mutsu/Crispin. Apply full rate of oil in 2,000–3,000 L of water per ha. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 48 hours of freezing temperatures or within 14 days of Supra Captan, Maestro, Folpan or any other product containing sulphur.
European fruit scale	• Purespray Green Spray Oil 13 E (NC)	20 L/1,000 L water	
Lecanium scale			

Disease or Insect	Product (Group)	Rate	Comments
Green tip to half-inch green			
Scab	• Manzate Pro-stick (M) or Dithane DG (M) or Penncozeb 75 Raincoat (M)	6 kg/ha 6 kg/ha 2 kg/1,000 L water	Apply fungicides before spore release and keep growing leaves covered. See <i>Apple scab</i> , page 57 for information on infection periods. Folpan: May cause russetting to Delicious and other sensitive varieties when used pink to 30 days after petal fall. Do not use within 14 days of oil. Fontelis, Luna Tranquility: In conditions of rapid growth or high disease pressure, use high rate, shorten intervals between applications and tank-mix with a protectant. Maximum of 2 applications per season. Vanguard, Scala: These products do not control other diseases. Maximum of 2 applications per season, prebloom only. Syllit: Resistance is present in some Ontario orchards. Check the status of resistance to U12 fungicides in your orchard before using it. Do not use after Tight cluster . Serenade MAX, Buran: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267 and <i>Using Organic and Biopesticide Products</i> , page 242.
	• Polyram DF (M)	6 kg/ha	
	• Supra Captan 80 WDG (M) or Maestro 80 DF (M)	3.75 kg/ha 3.75 kg/ha	
	• Folpan 80 WDG (M)	3.0–3.75 kg/ha	
	• Granuflo T (M) or Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water	
	• Fontelis (7)	1.0–1.5 L/ha	
	• Luna Tranquility (7+9) plus Dithane DG	800 mL/ha 3 kg/ha	
	• Vanguard 75 WG (9)	370 g/ha	
	• Scala SC (9)	1 L/ha	
	• Allegro 500 F (29)	0.75–1.0 L/ha	
	• Syllit 400 FL (U12)	1.75 L/ha	
	plus Supra Captan 80 WDG or Maestro 80 DF	2.8 kg/ha 2.8 kg/ha	
	• Syllit 400 FL (U12) plus Manzate Pro-stick or Dithane DG	1.75 L/ha 3.36 kg/ha 3.36 kg/ha	
	or Penncozeb 75 Raincoat	3.36 kg/ha	
	Powdery mildew	• Microscopic Sulphur (M) or Kumulus DF (M) or Microthiol Disperss (M)	
• Nova 40 W (3)		340 g/ha	
• Fontelis (7)		1.0–1.5 L/ha	
• Luna Tranquility (7+9)		600 mL/ha	
• Sovran (11)		240 g/ha	
• Flint (11)		140–210 g/ha	
• Pristine WG (7+11)		1.0–1.2 kg/ha	
Half-inch green to tight cluster			
European red mite	• Superior 70 Oil (NC)	20 L/1,000 L water	Oil may cause bark injury on Red Delicious, Empire and Mutsu/Crispin. Apply before overwintering eggs hatch. Apply full rate of oil in 2,000–3,000 L of water per ha. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 48 hours of freezing temperatures or within 14 days of Supra Captan, Maestro, Folpan or sulphur product. Do not apply to heat-stressed trees.
	• Purespray Green Spray Oil 13 E (NC)	20 L/1,000 L water	
Rosy apple aphid	• Assail 70 WP (4)	120 g/ha	Spray if 20 or more clusters in a 100-cluster sample are infested. Assail, Actara, Calypso, Closer: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Actara: Maximum 1 prebloom application. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Actara 25 WG (4)	145–290 mL/ha	
	• Calypso 480 SC (4)	160 g/ha	
	• Closer SC (4)	100–200 mL/ha	
	• Beleaf 50 SG (9)	160 g/ha	
	• Exirel (28)	1.5 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
Scab	• Manzate Pro-stick (M)	6 kg/ha	Resistance to Group 3, 11 and U12 fungicides has been confirmed in Ontario. Check the status of these products before using them in your orchard. See <i>Managing resistance to fungicides</i> , page 258. Do not use oil within 14 days of Supra Captan, Maestro or Folpan. Folpan: May cause russetting to Delicious or other sensitive varieties when used pink to 30 days after petal fall. Nova, Inspire Super, Sovran, Flint, Pristine: Do not use earlier than Tight cluster . Residues last 5–8 days. In conditions of rapid growth, shorten intervals between applications. Do not use if apple scab is present. Inspire Super: May provide suppression of powdery mildew when applied at high rate. Fontelis, Luna Tranquility, Pristine: In conditions of rapid growth or high disease pressure, use high rate, shorten intervals between applications and tank-mix with a protectant. Maximum of 2 applications per season. Vanguard, Scala: These products do not control other diseases. Maximum of 2 applications per season, prebloom only. Do not use if apple scab is present. Syllit: Do not use after Tight cluster . Serenade MAX, Buran: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267 and <i>Using Organic and Biopesticide Products</i> , page 242.
	• Dithane DG (M)	6 kg/ha	
	• Penncozeb 75 Raincoat (M)	2 kg/1,000 L water	
	• Polyram DF (M)	3.75 kg/ha	
	• Supra Captan 80 WDG (M)	6 kg/ha	
	• Maestro 80 DF (M)	3.75 kg/ha	
	• Folpan 80 WDG (M)	3–3.75 kg/ha	
	• Granuflo T (M)	1.5–2.25 kg/1,000 L water	
	• Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water	
	• Nova 40 W (3)	340 g/ha	
	• plus 1/2 rate Group M	see Group M above	
	• Inspire Super (3+9)	560–836 mL/ha	
	• Fontelis (7)	1.0–1.5 L/ha	
	• Luna Tranquility (7+9)	800 mL/ha	
	• plus Dithane DG	3 kg/ha	
	• Vanguard 75 WG (9)	370 g/ha	
	• Scala SC (9)	1 L/ha	
	• Sovran (11)	240 g/ha	
	• plus 1/2 rate Group M	see Group M above	
	• Flint (11)	140 g/ha	
• plus 1/2 rate Group M	see Group M above		
• Pristine WG (7+11)	1.0–1.2 kg/ha		
• plus 1/2 rate Group M	see Group M above		
• Allegro 500 F (29)	0.75–1.0 L/ha		
• Syllit 400 FL (U12)	1.75 L/ha		
• plus Supra Captan 80 WDG	2.8 kg/ha		
• or Maestro 80 DF	2.8 kg/ha		
• Syllit 400 FL (U12)	1.75 L/ha		
• plus Manzate Pro-stick	3.36 kg/ha		
• or Dithane 75 DG	3.36 kg/ha		
• or Penncozeb 75 Raincoat	3.36 kg/ha		
Powdery mildew	Use one of the products listed for powdery mildew at Green tip to half-inch green .		
Oriental fruit moth (OFM)	• Isomate-M 100	250 dispensers/ha	Place dispensers in orchards in late April before flight begins. Outbreaks of other pests may occur when insecticides are not used for OFM. See <i>Mating Disruption in Fruit Crops</i> , page 250. Isomate-M 100: Will provide control for up to 90 days. Re-apply 75–80 days after initial application for late-season varieties. Isomate-M Rosso: Will provide control for up to 120 days.
	• Isomate-M Rosso	500 dispensers/ha	
Tight cluster to pink			
Tentiform leafminer	• Pounce 384 EC (3)	520 mL/ha	Apply if there are 3 or more eggs per spur or 1 or more sap-feeders per leaf. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer: Apply at first egg hatch. This group is highly toxic to beneficial insects, and may lead to mite outbreaks. Maximum of 1 application per season. Assail, Actara, Calypso: Apply when population is mainly in the sap-feeder stage. Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Delegate, Altacor, Exirel: Apply when population is mainly in the sap-feeder stage. Intrepid, Confirm: Apply at first egg hatch. Confirm provides suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Perm-Up (3)	520 mL/ha	
	• Ambush 500 EC (3)	400 mL/ha	
	• Decis 5 EC (3)	250 mL/ha	
	• Ripcord (3)	250 mL/ha	
	• or Up-Cyde 2.5 EC (3)	400 mL/ha	
	• Matador 120 EC (3)	83 mL/ha	
	• or Silencer 120 EC (3)	83 mL/ha	
	• Assail 70 WP (4)	80 g/ha	
	• Actara 25 WG (4)	315 g/ha	
	• Calypso 480 SC (4)	145 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Intrepid 240 F (18)	500 mL/ha	
	• Confirm 240 F (18)	1 L/ha	
	• Altacor (28)	215 g/ha	
	• Exirel (28)	500–750 mL/ha	

Disease or Insect	Product (Group)	Rate	Comments
Scab	Use one of the products listed for scab at Half-inch green to tight cluster .		
Powdery mildew	Use one of the products listed for powdery mildew at Green tip to half-inch green .		
Rust	- Ferbam 76 WDG (M) - Polyram DF (M) - Manzate Pro-stick (M) - or Dithane DG (M) - or Penncozeb 75 Raincoat (M) - Granuflo T (M) - Thiram 75 WP (M) - Nova 40 W (3) - Inspire Super (3+9) - Fontelis (7) - Flint (11)	1.25–2.0 kg/1,000 L water 6 kg/ha 6 kg/ha 6 kg/ha 2 kg/1,000 L water 1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water 340 g/ha 836 mL/ha 1.0–1.5 L/ha 140 g/ha	If the alternate host, Eastern red cedar, is nearby, include in sprays up to and including First summer spray . Ferbam: May cause russetting on Golden Delicious and other sensitive varieties. Nova, Inspire Super: These products are weak on fruit scab and should be tank-mixed with a protectant fungicide. See options for apple scab control at Half-inch green to tight cluster . Fontelis: Use the higher rate and shorter interval when disease pressure is high. Maximum of 2 applications per season.
Plant bugs	- Ripcord (3) - or Up-Cyde 2.5 EC (3) - Matador 120 EC (3) - or Silencer 120 EC (3) - Ambush 500 EC (3)	250 mL/ha 400 mL/ha 104 mL/ha 104 mL/ha 400 mL/ha	These products are highly toxic to beneficial insects, and may lead to mite outbreaks. Do not apply when bees are active in the orchard. Maximum of 1 application per season.
Codling moth (CM) Oriental fruit moth (OFM)	Isomate-CM/OFM TT	500 dispensers/ha	Reduces mating of CM and OFM. Place pheromone traps for monitoring CM in orchard by bloom. Apply dispensers no later than petal fall, before first CM flight. Dispensers last up to 150 days for CM and up to 90 days for OFM. See <i>Mating Disruption in Fruit Crops</i> , page 250. Most orchards will require insecticides for one or both CM generations. Insecticides for OFM may be needed in late varieties where high OFM populations exist.
Spring-feeding caterpillars	- Imidan 70-WP Instapak (1) - Altacor (28) - Exirel (28)	2.68 kg/ha 145–285 g/ha 0.5–1.0 L/ha	Apply if there are 12–15 larvae in 100 terminals. Altacor, Exirel: Re-apply, if necessary, 10–14 days later. Use high rate under high pressure. Do not tank-mix or make sequential applications of Exirel with strobilurins, copper or captan fungicides.
Pink			
Scab	Use one of the products listed for scab at Half-inch green to tight cluster .		
Powdery mildew	Use one of the products listed for powdery mildew at Green tip to half-inch green .		
Black rot	- Supra Captan 80 WDG (M) - or Maestro 80 DF (M) - Folpan 80 WDG (M) - Granuflo T (M) - or Thiram 75 WP (M)	3.75 kg/ha 3.75 kg/ha 3.0–3.75 kg/ha 1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water	Apply fungicides preventatively to susceptible varieties in orchards with a history of black rot infections. Do not use oil within 14 days of Supra Captan, Maestro or Folpan. Folpan: May cause russetting to Delicious or other sensitive varieties when used pink to 30 days after petal fall.
Rosy apple aphid	- Assail 70 WP (4) - Calypso 480 SC (4) - Closer SC (4) - Beleaf 50 SG (9) - Exirel (28)	120 g/ha 145–290 mL/ha 100–200 mL/ha 160 g/ha 1.5 L/ha	Spray if 20 or more clusters in a 100-cluster sample are infested. Some products are toxic to bees. Do not apply during bloom or when bees are active in the orchard. Refer to label for specific bee toxicity statements. Assail, Calypso, Closer: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
European apple sawfly	- Assail 70 WP (4) - Calypso 480 SC (4) - Exirel (28)	240 g/ha 290 mL/ha 1 L/ha	Apply where there has been a history of damage. Use 3-D white sticky traps to monitor for sawfly adults. Re-apply at petal fall if monitoring indicates populations have reached economic thresholds. Some products are toxic to bees. Do not apply during bloom or when bees are active in the orchard. Refer to label for specific bee toxicity statements. Assail, Calypso: Maximum of 2 applications from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Bloom			
DO NOT APPLY INSECTICIDES WHILE APPLE TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Scab	- Manzate Pro-stick (M) or Dithane DG (M) - Penncozeb 75 Raincoat - Polyram DF (M) - Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Folpan 80 WDG (M) - Granuflo T (M) or Thiram 75 WP (M) - Nova 40 W (3) plus 1/2 rate Group M - Inspire Super (3+9) - Fontelis (7) - Sovran (11) plus 1/2 rate Group M - Flint (11) plus 1/2 rate Group M - Pristine WG (7+11) plus 1/2 rate Group M - Allegro 500 F (29)	6 kg/ha 6 kg/ha 2 kg/1,000 L water 6 kg/ha 3.75 kg/ha 3.75 kg/ha 3.0–3.75 kg/ha 1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water 340 g/ha see Group M above 560–836 mL/ha 1.0–1.5 L/ha 240 g/ha see Group M above 140 g/ha see Group M above 1.0–1.2 kg/ha see Group M above 0.75–1.0 L/ha	Resistance to Group 3 and 11 fungicides has been confirmed in Ontario. Check the status of these products before using them in your orchard. See <i>Managing resistance to fungicides</i>, page 258. Folpan: May cause russetting to Delicious or other sensitive varieties when used pink to 30 days after petal fall. Nova, Inspire Super, Sovran, Flint, Pristine: Residues last 5–8 days. In conditions of rapid growth, shorten intervals between applications. Do not use if apple scab is present. Nova, Inspire Super: Weak on fruit scab, so do not use these products for scab after bloom. Fontelis, Pristine: In conditions of rapid growth or high disease pressure, use high rate, shorten intervals between applications and tank-mix with a protectant. Maximum of 2 applications per season. Serenade MAX, Buran: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242.
Fire blight	- Kasumin 2L (24) - Streptomycin 17 (25) - Blossom Protect (NC)	5.0 L/ha 600 g/1,000 L water See comments	Models to time fire blight sprays (e.g., Maryblyt, Cougar Blight) are available. See www.ontario.ca/cropIPM. Otherwise, apply sprays if temperatures over 18°C are accompanied by high humidity (over 69%), heavy dews or rainfall. Spray susceptible varieties beginning at first bloom until petal fall. Products are most effective when applied prior to an infection period. Use alone for best results. Kasumin: Apply at 20–30% bloom, or when conditions favour disease development. Streptomycin: UV-sensitive and re-application is needed after 2–3 days if warm, wet conditions (above 18°C) are forecast. Blossom Protect: For every 1 m of tree height, dilute 5.25 kg Component A in 500 L/ha water and add dilution to 0.75 kg Component B. If a forecast system is available, apply 1–2 days before an infection date. Repeat after 2 days and up to 5 times if infection continues. If no forecast system is available, apply at 10, 40, 70 and 90% open blossoms. This product is sensitive to fungicides and may have reduced efficacy if tank-mixed. Russetting may occur on sensitive varieties. Serenade MAX, Bloomtime Biological FD: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242.

Disease or Insect	Product (Group)	Rate	Comments
Late bloom/early petal fall			
Fire blight (suppression of shoot blight stage)	• Apogee	1.35 kg/ha	Reduces vegetative growth, making trees less susceptible to fire blight shoot infection. Apogee has no impact on blossom blight or the fire blight bacteria. Apply in late bloom or early petal fall when shoots are 2.5–5.5 cm long. Accurate timing is critical. Apogee will help suppress fire blight infections from this point on. Re-apply spray 14–21 days later. In plantings with low vigour, a reduction in shoot growth caused by the high rate of Apogee for fire blight suppression may be undesirable. For more information on the use of Apogee refer to <i>Vegetative growth control in apples</i>, page 75.
Petal fall (Calyx) when most petals have fallen			
Some products control more than one pest. See Table 3-8. <i>Activity of Petal Fall Insecticides Against Orchard Pests</i> , page 53.			
Scab	Use one of the products listed for scab at Bloom .		
Bitter rot	• Granuflo T (M) or Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water	Apply fungicides preventatively to susceptible varieties in orchards with a history of bitter rot infections.
Black rot	Use one of the products listed for black rot at Pink .		
Dogwood borer	• Isomate DWB	250–375 dispensers/ha	Apply before adult borer emergence (end of May). Use high rate for high-pressure areas or initial year of treatment. See <i>Mating Disruption in Fruit Crops</i> , page 250.
Tentiform leafminer	• Pounce 384 EC (3) - or Perm-Up (3) - or Ambush 500 EC (3) • Decis 5 EC (3) • Ripcord (3) - or Up-Cyde 2.5 EC (3) • Matador 120 EC (3) - or Silencer 120 EC (3) • Admire 240 F (4) - or Alias 240 SC (4) • Assail 70 WP (4) • Actara 25 WG (4) • Calypso 480 SC (4) • Clutch 50 WDG (4) • Delegate WG (5) • Agri-Mek 1.9% EC (6) • Altacor (28) • Exirel (28)	520 mL/ha 520 mL/ha 400 mL/ha 250 mL/ha 250 mL/ha 400 mL/ha 83 mL/ha 83 mL/ha 380 mL/ha 380 mL/ha 80 g/ha 315 g/ha 145 mL/ha 140–210 g/ha 420 g/ha 750 mL/ha 215 g/ha 500–750 mL/ha	Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements. Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer: If egg hatch is delayed, apply at petal fall when first sap-feeding mine is detected. These products are highly toxic to beneficial insects, and may lead to mite outbreaks. Maximum of 1 application of product from this group per season. Admire, Alias, Assail, Actara, Calypso, Clutch: Apply when population is mainly in the sap-feeder stage. Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Delegate, Altacor, Exirel: Apply when population is mainly in the sap-feeder stage. Agri-Mek: Do not apply later than 21 days after petal fall. Apply with 10 L of oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russetting on Golden Delicious and other light-skinned cultivars. Do not use within 14 days of Supra Captan, Maestro or Folpan fungicides. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Rosy apple aphid	• Admire 240 F (4) - or Alias 240 SC (4) • Assail 70 WP (4) • Actara 25 WG (4) • Calypso 480 SC (4) • Clutch 50 WDG (4) • Closer SC (4) • Beleaf 50 SG (9) • Movento 240 SC (23) • Exirel (28)	230 mL/ha 230 mL/ha 120 g/ha 160 g/ha 140–210 g/ha 145–290 mL/ha 100–200 mL/ha 160 g/ha 365 mL/ha 1.5 L/ha	Spray if 20 or more clusters in a 100-cluster sample are infested. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements. Admire, Alias, Assail, Actara, Calypso, Clutch, Closer: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Movento: Control may not be apparent for 2–3 weeks. Under high pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Mullein bug	- Diazinon 50 WSP (1) - Admire 240 F (4) - or Alias 240 SC (4) - Assail 70 WP (4) - Actara 25 WG (4) - Calypso 480 SC (4)	3.25 kg/ha 380 mL/ha 380 mL/ha 80–160 g/ha 315 g/ha 290 mL/ha	Apply controls where 7–9 nymphs are caught per 25 taps. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements. Admire, Alias, Assail, Actara, Calypso: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks.
San Jose scale Oystershell scale	- Closer SC (4) - Movento 240 SC (23)	400 mL/ha 365 mL/ha	Apply when the crawlers are active in orchards with a history of scale. These products are toxic to bees. Do not apply when bees are active in the orchard. Movento: Control may not be apparent for 2–3 weeks. Under high pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur.
Plum curculio	- Imidan 70-WP Instapak (1) - Assail 70 WP (4) - Actara 25 WG (4) - Calypso 480 SC (4) - Clutch 50 WDG (4) - Exirel (28) - Surround WP (NC)	2.68 kg/ha 120–240 g/ha 385 g/ha 440 mL/ha 210 g/ha 1.0–1.5 L/ha 50 kg/ha	Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements. Imidan: Apply immediately at petal fall, or when monitoring indicates plum curculio is in the orchard. Assail, Actara, Calypso, Clutch: Apply at petal fall plus 3 days, or earlier if monitoring indicates plum curculio is in the orchard. Do not use as a border spray. Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Exirel: Apply at first sign of feeding damage after bloom. Re-apply 10–14 days later, if monitoring indicates a need. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Surround: Must be applied before plum curculio is present. Make 2 initial applications at 50 kg/ha, 7 days apart, to establish a base layer. Continue at 7–14-day intervals, using a reduced rate of 25 kg/ha, to maintain even coverage of developing fruits. Do not use Surround in border sprays. See <i>Using Organic and Biopesticide Products</i>, page 242.
European apple sawfly	- Assail 70 WP (4) - Calypso 480 SC (4) - Altacor (28) - Exirel (28)	240 g/ha 290 mL/ha 215 g/ha 1 L/ha	Apply where there has been a history of damage. Use 3-D white sticky traps to monitor for sawfly adults. If a prebloom insecticide has been applied, spray postbloom when 6 sawflies have been caught per trap. Where no prebloom insecticides have been applied, spray postbloom when 3 sawflies have been caught per trap. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements. Assail, Calypso: Maximum of 2 applications from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
European red mite	• Agri-Mek 1.9% EC (6)	750 mL/ha	Thorough spray coverage is essential for good control. Miticides are best applied alone. See Table 3-9. <i>Activity of Miticides Registered on Apple and/or Pear in Ontario</i>, page 53. Agri-Mek: Apply when there are 5–7 active mites per leaf timed for 50% egg hatch, no later than 21 days after petal fall. Apply with 10 L of oil and a minimum of 1,000 L of water per ha. May cause russetting on Golden Delicious and other light-skinned varieties. Do not use within 14 days of Supra Captan, Maestro or Folpan fungicides. Agri-Mek, Envidor: Also control apple rust mites. Apollo: Apply when mites are mostly in the egg stage and before there are more than 3 active mites per leaf. Kanemite, Envidor, Acramite: Apply when there are 5–7 active mites per leaf. Envidor: Control may not be apparent for up to 1 week. Purespray Green Spray Oil 13E: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242. Do not use within 14 days of Supra Captan, Maestro or Folpan fungicides.
	• Apollo SC (10)	300 mL/ha	
	• Kanemite 15 SC (20)	2.1 L/ha	
	• Envidor 240 SC (23)	750 mL/ha	
	• Acramite 50 WS (UN)	851 g/ha or 3.75 pouches/ha	
Blister spot	• Aliette (33)	2 kg/ha	Apply preventatively to susceptible varieties such as Mutsu/Crispin, Jonagold and Golden Delicious. Begin applications at petal fall with 1–2 subsequent sprays at 7-day intervals. Do not mix with copper compounds.
Obliquebanded leafroller (OBLR)	• Success (5)	182 mL/ha	Spray overwintering OBLR in orchards with historical pest problems or high pest pressure (1–2% of the terminals or buds have larvae or damage). Place pheromone traps in orchards at petal fall to monitor emergence of summer-generation OBLR. Dipel, Foray, Bioprotec: If larvae activity is extended, re-apply 5–7 days later. See <i>Using Organic and Biopesticide Products</i>, page 242. Intrepid, Confirm: Cross-resistance to this group and pyrethroids may be possible in organophosphate-resistant OBLR populations. Exirel: If larvae activity is extended, re-apply 10 days later. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• or Entrust SC (5)	364 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Dipel 2X DF (11)	1.12 kg/ha	
	• or Foray 48BA (11)	2.8 L/ha	
	• or Bioprotec CAF (11)	4 L/ha	
	• Intrepid 240 F (18)	750 mL/ha	
	• Confirm 240 F (18)	1 L/ha	
Oriental fruit moth (OFM)	• Altacor (28)	285 g/ha	This is a special spray for orchards where there is a history of damage. Adjust spray timing based on monitoring. Apply insecticides 6–10 days after upswing in pheromone trap catches, which often coincides with petal fall. Alternatively, accumulate degree-days (base 7.2°C) at first sustained moth catch (biofix) and apply insecticides targeting first-generation larvae: Decis: Apply at 194–208 DDC or earlier. Highly toxic to beneficial insects and may lead to mite outbreaks. Maximum of 1 application per season. Apply in 3,000 L water. Assail, Calypso: Apply at 139–153 DDC for eggs or larvae. Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Rimon: Apply at 111–139 DDC. Use for first generation only. See notes for codling moth, on next page. Intrepid: Apply at 139–153 DDC for eggs or larvae. Altacor, Exirel, Delegate: Apply at 194–208 DDC or earlier if using as an ovi-larvicide. Do not tank-mix or make sequential applications of Exirel with strobilurin, copper or captan fungicides. See Appendix B: <i>Degree-Day Modeling</i>, page 291. If an insecticide is used at this time to manage OFM, mating disruption may be delayed until mid-June. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements.
	• Exirel (28)	0.5–1.0 L/ha	
	• Decis 5 EC (3)	250 mL/ha	
	• Assail 70 WP (4)	240 g/ha	
	• Calypso 480 SC (4)	440 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Rimon 10 EC (15)	1.4 L/1,000 L water	
	• Intrepid 240 F (18)	1 L/ha	

Disease or insect	Product (Group)	Rate	Comments
Codling moth	• Rimon 10 EC (15)	1.4 L/1,000 L water	Apply at petal fall and re-apply 10–14 days later. Use for first generation only. See label for additional information on rates and volumes. Do not allow Rimon to drift onto grapes as leaf spotting may occur. Applied at this time, will provide subsequent control of obliquebanded leafroller and oriental fruit moth. Toxic to bees and bee colonies. Do not apply when bees are active in the orchard.
Leafcurling midge	• Ripcord (3) or Up-Cyde 2.5 EC (3)	250 mL/ha 400 mL/ha	This is a special spray for orchards where there is a history of damage. Ripcord, Up-Cyde: Maximum of 1 application of product from this group per season. These products are highly toxic to beneficial insects and may lead to mite outbreaks. Do not apply when bees are active in the orchard.
Powdery mildew	Use one of the products listed for powdery mildew at Green tip to half-inch green .		
First summer spray – 7–14 days after petal fall (Calyx)			
Scab	Use one of the products listed for scab at Bloom . An extra scab spray may be required between Petal fall (Calyx) and First summer spray . See <i>Control of apple scab under adverse weather conditions</i> , page 60.		
Plum curculio	Use one of the products listed for plum curculio at Petal fall (Calyx) .		
Fire blight	• Streptomycin 17 (25)	600 g/1,000 L water	Apply to control shoot blight especially if blossom blight has occurred.
European red mite (ERM)	• Agri-Mek 1.9% EC (6)	750 mL/ha	Thorough spray coverage is essential for good control. Miticides are best applied alone. See Table 3-9. <i>Activity of Miticides Registered on Apple and/or Pear in Ontario</i> , page 53. Agri-Mek: Apply when there are 5–7 active mites per leaf timed for 50% egg hatch, no later than 21 days after petal fall. Apply with 10 L of oil and a minimum of 1,000 L of water per ha. May cause russetting on Golden Delicious and other light-skinned cultivars. Do not apply within 14-days of Supra Captan, Maestro or Folpan fungicides. Agri-Mek, Envidor: Also control apple rust mites. Apollo: Apply when mites are mostly in the egg stage and before there are more than 3 active mites per leaf. Kanemite, Envidor, Acramite: Apply when there are 5–7 active mites per leaf. Envidor: Control may not be apparent for up to 1 week. Acramite: Use low rate for two-spotted spider mite and high rate for European red mite. Purespray Green Spray Oil 13E: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267 and <i>Using Organic and Biopesticide Products</i> , page 242. Do not use within 14 days of Supra Captan, Maestro or Folpan fungicides.
Two-spotted spider mite (TSSM)	• Apollo SC (10)	300 mL/ha	
	• Kanemite 15 SC (20)	2.1 L/ha	
	• Envidor 240 SC (23)	750 mL/ha	
	• Acramite 50 WS (UN)	568 or 851 g/ha (2.5 or 3.75 pouches/ha)	
Rosy apple aphid	Use one of the products listed for rosy apple aphid at Petal fall . At this timing, Clutch 50 WDG applied at 210–420 g/ha provides suppression of oriental fruit moth and codling moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.		
Powdery mildew	Use one of the products listed for powdery mildew at Green tip to half-inch green .		
Blister spot	• Copper 53 W (4) • Aliette (33)	3 kg/ha 2 kg/ha	Apply preventatively to Mutsu/Crispin, Golden Delicious and other susceptible varieties. Copper: Apply up to 3 sprays beginning 10 days after petal fall. To reduce the risk of phytotoxicity, use 6 kg of hydrated lime per 1 kg of Copper 53 W per 1,000 L of water. Apply in 3,000 L of water per ha. Aliette: Begin applications at petal fall and spray at 7-day intervals. Do not mix with copper.
Oriental fruit moth (OFM)	• Isomate-M 100 • Isomate-M Rosso	250 dispensers/ha 500 dispensers/ha	See <i>Mating Disruption in Fruit Crops</i> , page 250. Isomate-M 100: Will provide control for 75–80 days. Isomate-M Rosso: Will provide control for up to 120 days.

Disease or Insect	Product (Group)	Rate	Comments
Codling moth (first generation)	• Imidan 70-WP Instapak (1)	2.68 kg/ha	Apply as a full cover spray. Use pheromone traps to time sprays. Apply insecticides between 83–138 DDC (base 10°C) after first sustained moth catch. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Imidan, Delegate, Altacor: Apply at 138 DDC. Delegate and Altacor residues last 10–14 days. Assail, Calypso: Apply at 111–138 DDC. Residues last 10–14 days. Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Intrepid, Confirm: Apply at 83–111 DDC. Intrepid residues last 14 or more days. Exirel: Apply at 83–111 DDC. Residues last 10–14 days. Do not tank-mix or make sequential applications with strobilurin, copper or captan fungicides. Granulosis virus (Virosoft CP4, CYD-X): May provide control of codling moth when used in conjunction with other active ingredients. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Assail 70 WP (4)	170 g/ha	
	• Calypso 480 SC (4)	440 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Intrepid 240 F (18)	1 L/ha	
	• Confirm 240 F (18)	1 L/ha	
	• Altacor (28)	215 g/ha	
	• Exirel (28)	500–750 mL/ha	
Subsequent summer sprays			
Scab	Until the end of the primary scab season, use one of the products listed for scab at Bloom. For summer (secondary) scab control, use one of the following:		
	• Manzate Pro-stick (M) or Dithane DG (M) or Penncozeb 75 Raincoat (M)	6 kg/ha (5) 6 kg/ha (5) 2 kg/1,000 L water (1.5)	If scab is controlled in your orchard, use the lower rate given in brackets. Polyram, Manzate, Dithane, Penncozeb: Do not apply within 45 days of harvest. Folpan: May cause russetting to Delicious or other sensitive varieties when used pink to 30 days after petal fall. Allegro: May suppress European red mite, two-spotted spider mite and apple rust mite.
	• Polyram DF (M)	6 kg/ha (4.5)	
	• Supra Captan 80 WDG (M) or Maestro 80 DF (M)	3.75 kg/ha (1.9) 3.75 kg/ha (1.9)	
	• Folpan 80 WDG (M)	3.0–3.75 kg/ha	
	• Granuflo T (M)	1.5–2.25 kg/1,000 L water (1.0–1.5)	
	or Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water (1.0–1.5)	
	• Allegro 500 F (29)	0.75–1.0 L/ha	
Sooty blotch Fly speck	• Supra Captan 80 WDG (M) or Maestro 80 DF (M)	3.75 kg/ha 3.75 kg/ha	Begin fungicide coverage for these diseases at Petal fall, if fly speck and sooty blotch were a problem in the past. Captan, Maestro: Re-apply 2-weeks later. At full rates, these products protect against fruit rot. Folpan: May cause russetting to Delicious or other sensitive varieties when used pink to 30 days after petal fall. Inspire Super: Weak on fruit scab and should be tank-mixed with a protectant fungicide. See options for apple scab control at Half-inch green to tight cluster. Pristine: In conditions of rapid growth or high disease pressure, use high rate and shorten interval between applications. Allegro: May suppress European red mite, two-spotted spider mite and apple rust mite.
	• Folpan 80 WDG (M)	3.0–3.75 kg/ha	
	• Granuflo T (M)	1.5–2.25 kg/1,000 L water	
	or Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water	
	• Inspire Super (3+9)	836 mL/ha	
	• Flint (11)	140 g/ha	
	• Pristine WG (7+11)	600–800 g/ha	
	• Allegro 500 F (29)	0.75–1.0 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
Codling moth (second generation)	• Imidan 70-WP Instapak (1)	2.68 kg/ha	Use pheromone traps to time sprays. For second-generation codling moth, spray at 611–694 DDC (base 10° C) after first-generation sustained moth catch. See Appendix B: <i>Degree-Day Modeling</i>, page 291. At this timing, Imidan may be effective as a border spray if there is no resident population in the orchard. Use a full cover spray for all other products. Imidan, Altacor, Exirel, Delegate: Apply at 667–694 DDC. Assail, Calypso: Apply at 639–667 DDC. Residues last 10–14 days. Use a maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Intrepid and Confirm: Apply at 611–639 DDC. Intrepid residues last 14+ days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Granulosis virus (Virosoft CP4, CYD-X): May provide control of codling moth when used in conjunction with other active ingredients. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Assail 70 WP (4)	170 g/ha	
	• Calypso 480 SC (4)	440 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Intrepid 240 F (18)	1 L/ha	
	• Confirm 240 F (18)	1 L/ha	
	• Altacor (28)	215 g/ha	
• Exirel (28)	500–750 mL/ha		
Oriental fruit moth	• Isomate-M 100	250 dispensers/ha	See <i>Mating Disruption in Fruit Crops</i>, page 250. Isomate-M 100: Provides control for up to 75–80 days. Isomate-M Rosso: Provides control for up to 120 days.
	• Isomate-M Rosso	500 dispensers/ha	
Apple maggot	• Imidan 70-WP Instapak (1)	2.68 kg/ha	Apply 7 days after the first adult maggot is caught on a sticky board. Make subsequent applications at 14–21-day intervals, or as required based on monitoring. Imidan, Diazinon: Residue lasts 18–21 days. Assail, Calypso: Residue lasts 14-days. Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Do not use as a border spray. Exirel: Residue lasts 10–14-days. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Surround: Begin applications well before first maggot flies are trapped in commercial orchards. Use 50 kg/ha for the first 2 applications, and continue at 7–14-day intervals using 25 kg/ha to maintain even coverage of fruit as long as flies continue to be captured. Do not use as a border spray. See <i>Using Organic and Biopesticide Products</i>, page 242. Altacor, GF-120 Fruit Fly Bait: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242. Apply Altacor at 285 g/ha.
	• Diazinon 50 WSP (1)	1 kg/1,000 L water	
	• Assail 70 WP (4)	120–240 g/ha	
	• Calypso 480 SC (4)	440 mL/ha	
	• Exirel (28)	1.5 L/ha	
	• Surround WP (NC)	50 kg/ha	
Special summer sprays			
Brown marmorated stink bug	• Malathion 85 E (1)	1.22 L/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply when insects first appear. Malathion, Actara, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267
	• Lannate Toss-N-Go (1)	2.1 kg/ha	
	• Actara 25 WG (4)	385 g/ha	
	• Clutch 50 WDG (4)	210–420 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Blister spot	Use one of the products listed for blister spot in First summer spray .		
Green apple aphid (GAA)	• Diazinon 50 WSP (1)	0.5–1.0 kg/1,000 L water	Spray for GAA if 10% of terminals are infested. Sprays can be delayed or avoided if predators are present on more than 20% of infested terminals. Spray for RAA if 20 or more infested clusters are present per 100 clusters examined. Admire, Alias, Assail, Calypso, Clutch, Closer: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Clutch: Applied at 210–420 g/ha provides suppression of oriental fruit moth and codling moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Movento: Control may not be apparent for 2–3 weeks. Under high pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Rosy apple aphid (RAA)	• Admire 240 F (4)	230 mL/ha	
	• or Alias 240 SC (4)	230 mL/ha	
	• Assail 70 WP (4)	120 g/ha	
	• Calypso 480 SC (4)	145–290 mL/ha	
	• Clutch 50 WDG (4)	140–210 g/ha	
	• Closer SC (4)	100–200 mL/ha	
	• Beleaf 50 SG (9)	160 g/ha	
	• Movento 240 SC (23)	365 mL/ha	
	• Exirel (28)	1.5 L/ha	
Woolly apple aphid	• Diazinon 500 E (1)	0.5–1.0 L/1,000 L water	Spray if aphid colonies are close to fruit clusters or on young trees and nursery stock. Use high volumes of water and ensure spray contacts trunk and scaffold limbs. Repeat application in 14-days if woolly apple aphid is still present. Malathion 85 E: May cause injury to McIntosh and Cortland if applied within 4 weeks of harvest. Movento: Control may not be apparent for 2–3 weeks. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Closer: Suppression only at 200 mL/ha. See Table 11-1, <i>Pesticide Efficacy Ratings</i>, page 267.
	• Malathion 25 W (1)	2–5 kg/1,000 L water	
	• or Malathion 85 E (1)	610 mL/1,000 L water	
	• Movento 240 SC (23)	365 mL/ha	
White apple leafhopper	• Sevin XLR (1)	3.1 L/ha	Spray when 2–5 nymphs per leaf. Nymphs are active in mid-June and early August. Control of adults is very difficult. Best timing for control is after petal fall, if threshold is reached. Admire, Alias, Assail, Calypso, Clutch: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Clutch: Applied at 210–420 g/ha provides suppression of oriental fruit moth and codling moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Assail: Applied at 120 g/ha for aphids will also control leafhoppers. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Altacor: Suppression only at 285 g/ha. See Table 11-1, <i>Pesticide Efficacy Ratings</i>, page 267.
	• Admire 240 F (4)	200 mL/ha	
	• or Alias 240 SC (4)	200 mL/ha	
	• Calypso 480 SC (4)	145 mL/ha	
	• Clutch 50 WDG (4)	140–210 g/ha	
	• Altacor (28)	285 g/ha	
	• Exirel (28)	1 L/ha	
Potato leafhopper	• Calypso 480 SC (4)	145 mL/ha	Apply where monitoring indicates a potential problem. Calypso, Clutch: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Clutch: Applied at 210–420 g/ha provides suppression of oriental fruit moth and codling moth. See Table 11-1. <i>Pesticide Efficacy Rating</i>, page 267. Assail: Applied at 120 g/ha for aphids will also control leafhoppers.
	• Clutch 50 WDG (4)	140–210 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Tentiform leafminer	• Pounce 384 EC (3)	520 mL/ha	From petal fall through to June, apply controls where there is 1 or more sap-feeding mines per leaf. From mid to late June through July, apply where there are 2 mines per leaf (stressed trees) or 4 mines per leaf (healthy trees). Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer: Use is discouraged for summer generations of tentiform leafminer. These products are highly toxic to beneficial insects and may lead to mite outbreaks. Admire, Alias, Assail, Calypso, Clutch: Maximum of 2 applications of products from this group per season. Repeated use may result in mite outbreaks. Calypso: Note rate change from first to second generation. Clutch: Applied at 210–420 g/ha provides suppression of oriental fruit moth and codling moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• or Perm-Up (3)	520 mL/ha	
	• or Ambush 500 EC (3)	400 mL/ha	
	• Decis 5 EC (3)	250 mL/ha	
	• Ripcord (3)	250 mL/ha	
	• or Up-Cyde 2.5 EC (3)	400 mL/ha	
	• Matador 120 EC (3)	83 mL/ha	
	• or Silencer 120 EC (3)	83 mL/ha	
	• Admire 240 F (4)	380 mL/ha	
	• or Alias 240 SC (4)	380 mL/ha	
	• Assail 70 WP (4)	80 g/ha	
	• Calypso 480 SC (4)	290 mL/ha	
	• Clutch 50 WDG (4)	140–210 g/ha	
Dogwood borer Apple bark borer	• Delegate WG (5)	420 g/ha	Apply insecticides to tree trunk 7 days after peak flight of adults in orchards with a history of borer problems. Make applications at 2-week intervals. Direct the spray to the lower portion of the trunk, particularly the graft union and any pruning cuts. Delegate, Rimon, Altacor: Dogwood borer only. Rimon: Do not exceed 2,000 L of water per ha.
	• Altacor (28)	215 g/ha	
	• Exirel (28)	500–750 mL/ha	
	• Pounce 384 EC (3)	22 mL/100 L water	
	• plus oil	22 mL/100 L water	
	• or Perm-Up (3)	22 mL/100 L water	
Apple clearwing moth	• Delegate (5)	420 g/ha	This is not a common pest in Ontario. Apply insecticides to tree trunk within 10 days of first adult emergence and repeat application at 7–14-day intervals throughout the period of adult activity. Rimon: Do not exceed 2,000 L water per ha.
	• Rimon 10 EC (15)	1.4 L/1,000 L water	
	• Altacor (28)	285 g/ha	
Obliquebanded leafroller (OBLR)	• Entrust SC (5)	250 L/ha	Place pheromone traps in orchards by June to monitor adult populations. Insecticides for summer-generation larvae should be applied at 240–280 DDC after first sustained moth catch (base 6.1°C). See Appendix B: <i>Degree-Day Modeling</i>, page 291. Success, Entrust: Re-apply as necessary on a 7–10-day schedule. Dipel, Foray, Bioprotec: If larvae activity is extended, re-apply 5–7 days later. See <i>Using Organic and Biopesticide Products</i>, page 242. Exirel: If larvae activity is extended, re-apply 10 days later. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Intrepid, Confirm: Suppression only at this timing. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
	• Rimon 10 EC (15)	1.4 L/1,000 L water	
	• Success (5)	182 mL/ha	
	• or Entrust SC (5)	364 L/ha	
	• Delegate WG (5)	420 g/ha	
	• Dipel 2X DF (11)	1.12 kg/ha	
	• or Foray 48BA (11)	2.8 L/ha	
	• or Bioprotec CAF (11)	4 L/ha	
	• Altacor (28)	285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	
Oriental fruit moth (OFM)	• Success (5)	182 mL/ha	This is a special spray for orchards where there is a history of damage. Adjust spray timing based on monitoring. Apply insecticides 3–6 days after upswing in moth flight. Alternatively, accumulate degree-days (base 7.2°C) after first sustained moth catch (biofix) of the first generation. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Apply insecticides targeting second generation: Assail, Calypso, Intrepid: Apply at 750–778 DDC Decis, Delegate, Altacor, Exirel: Apply at 805–833 DDC. Apply insecticides targeting third generation (1st spray): Assail, Calypso, Intrepid: Apply at 1305–1333 DDC Decis, Delegate, Altacor, Exirel: Apply at 1361–1389 DDC. Apply insecticides targeting third generation (2nd spray): Assail, Calypso, Intrepid: Apply at 1556–1611 DDC Decis, Delegate, Altacor, Exirel: Apply at 1611–1667 DDC. Decis: Highly toxic to beneficial insects and may lead to mite outbreaks. Use only as a last resort. Apply in 3,000 L water. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Decis 5 EC (3)	250 mL/ha	
	• Assail 70 WP (4)	240 g/ha	
	• Calypso 480 SC (4)	440 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Intrepid 240 F (18)	1 L/ha	
	• Altacor (28)	215 g/ha	
	• Exirel (28)	500–750 mL/ha	
	• Success (5)	182 mL/ha	
	• or Entrust SC (5)	364 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
European red mite (ERM)	- Kanemite 15 SC (20) - Nexter (21) - Envidor 240 SC (23) - Acramite 50 WS (UN)	2.1 L/ha 300 g/ha 750 mL/ha 851 g/ha or 3.75 pouches/ha	Use a minimum of 1,000 L/ha of water when applying summer miticides. See Table 3-9. <i>Activity of Miticides Registered on Apple and/or Pear in Ontario</i>, page 53. Kanemite, Envidor, Acramite: Apply when there are 5 or more active mites per leaf. Nexter: Controls both nymphs and adults of ERM, but nymphs only for TSSM. Apply when there are 7–10 active mites per leaf in June to mid-July or 10–15 active mites per leaf in July and August. Nexter, Envidor: Also control apple rust mite. Envidor: Control may not be apparent for up to 1 week. Purespray Green Spray Oil 13E: Suppression only of European red mite. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242. Do not use within 14 days of Captan, Maestro or Folpan fungicides.
Two-spotted spider mite (TSSM)	- Kanemite 15 SC (20) - Nexter (21) - Envidor 240 SC (23) - Acramite 50 WS (UN)	2.1 L/ha 600 g/ha 750 mL/ha 568 g/ha or 2.5 pouches/ha	
Japanese beetle	- Imidan 70-WP Instapak (1) - Calypso 480 SC (4) - Exirel (28)	2.68 kg/ha 145–290 mL/ha 1.0–1.5 L/ha	This is a sporadic pest in Ontario that can cause economic damage, especially in young plantings of Honeycrisp. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Altacor: Suppression only at 285 g/ha. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Pinpoint and storage scab	Use one of the products listed for secondary scab in Subsequent summer sprays . Do not use fungicides closer than the stated interval to harvest. See Table 3-7. <i>Products Used on Apples</i> , page 50.		
Preharvest sprays			
Botrytis grey mould Penicillium storage diseases (suppression)	Scala SC (9)	2 L/ha	Scala: Apply 2 weeks before harvest. Captan, Maestro: Summer applications may provide some protection against storage rots.
Postharvest treatment			
Blue mould Grey mould	- Mertect SC (1) - Scholar 230 SC (12)	500 mL/500 L water 496 mL/378 L water	Mertect: Continuous agitation is required. Does not control blue or grey mould that are resistant to benzimidazole fungicides. Scholar: For use in dip tank or drencher. Treats up to 90,000 kg of fruit. For dip treatments, dip fruit for approximately 30 seconds, then allow fruit to drain. Bio-save 10 LP: Suppression only of storage rots. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Pseudomonas syringae</i> (Bio-Save 10 LP), page 256.

Guidelines for Protecting Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended for protection of bearing orchards. To minimize pest pressure, remove neglected fruit trees in the area and control weeds. Alternative materials are available as shown in the calendar for bearing fruits.

Disease or Insect	Product (Group)	Comments
Early spring		
Phytophthora collar rot	• Ridomil Gold 480 SL (4)	Do not apply if Ridomil was applied the previous fall.
First sprays		
Scab	• Manzate Pro-stick (M) - or Dithane DG (M) - or Penncozeb 75 Raincoat (M) • Polyram DF (M) • Supra Captan 80 WDG (M) - or Maestro 80 DF (M) • Folpan 80 WDG (M) • Granuflo T (M) - or Thiram 75 WP (M) • Fontelis (7) • Luna Tranquility (7+9) - plus Dithane	Apply fungicides before spore release and keep growing leaves covered. See <i>Apple scab</i>, page 57 for information on infection periods. Fontelis, Luna Tranquility: In conditions of rapid growth or high disease pressure, use high rate, shorten intervals between applications and tank-mix with a protectant. Maximum of 2 applications per season. Serenade MAX, Buran: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242.
Powdery mildew	• Microthiol Disperss (M) • Nova 40 W (3) • Fontelis (7) • Luna Tranquility (7+11) • Sovran (11) • Flint (11) • Pristine WG (7+11)	Begin application at Green tip to half-inch green and continue to First summer spray. Additional sprays beyond First summer spray may be needed on susceptible varieties or if disease pressure is severe. Inspire Super, Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. Apply Inspire Super at 836 mL/ha.
Prebloom		
Tentiform leafminer	• Pounce 384 EC (3) - or Perm-Up (3) - or Ambush 500 EC (3) • Decis 5 EC (3) • Ripcord (3) - or Up-Cyde 2.5 EC (3) • Matador 120 EC (3) - or Silencer 120 EC (3) • Assail 70 WP (4) • Actara 25 WG (4) • Calypso 480 SC (4) • Delegate WG (5) • Confirm 240 F (18) • Intrepid 240 F (18) • Altacor (28) • Exirel (28)	Monitor for tentiform leafminer and apply sprays when thresholds are reached. See comments on thresholds for tentiform at Tight cluster to pink stage, page 36. Some of these products are toxic to bees. Do not apply during bloom or when bees are active in the orchard. Refer to label for specific bee toxicity statements. Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer: Highly toxic to beneficial insects and may lead to mite outbreaks. Maximum of 1 application of product from this group per season. Assail, Actara, Calypso: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Spring-feeding caterpillars	• Imidan 70-WP Instapak (1) • Altacor (28) • Exirel (28)	Apply when caterpillars are small. Not necessary if a pyrethroid was used for tentiform leafminer. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Bloom		
Fire blight	• Kasumin 2L (24) • Streptomycin 17 (25) • Blossom Protect (NC)	Avoid overstimulating growth. See comments for fire blight at Bloom , page 38.

Disease or Insect	Product (Group)	Comments
Postbloom		
Leafcurling midge	• Ripcord (3) or Up-Cyde 2.5 EC (3)	These products are highly toxic to beneficial insects and may lead to mite outbreaks. Maximum of 1 application of product from this group per season.
Summer sprays		
Leaf-feeding insects	• Imidan 70-WP Instapak (1)	This spray will also control potato leafhopper.
Aphids	• Diazinon 50 WSP (1) • Admire 240 F (4) or Alias 240 SC (4) • Assail 70 WP (4) • Actara 25 WG (4) • Clutch 50 WDG (4) • Closer SC (4) • Movento 240 SC (23) • Exirel (28)	Spray if insects become abundant at any time. Admire, Alias, Assail, Actara, Clutch, Closer: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
White apple leafhopper	• Admire 240 F (4) or Alias 240 SC (4) • Assail 70 WP (4) • Calypso 480 SC (4) • Clutch 50 WDG (4) • Exirel (28)	Admire, Alias, Assail, Calypso, Clutch: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Potato leafhopper	• Assail 70 WP (4) • Calypso 480 EC (4) • Clutch 50 WDG (4)	Assail, Calypso, Clutch: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks.
Tentiform leafminer	• Vydate L (1) • Admire 240 F (4) or Alias 240 SC (4) • Assail 70 WP (4) • Actara 25 WG (4) • Calypso 480 EC (4) • Clutch 50 WDG (4) • Delegate WG (5) • Altacor (28) • Exirel (28)	Monitor for tentiform leafminer and apply sprays when thresholds are reached. See comments on thresholds for tentiform leafminer under Special summer sprays . Vydate: Very toxic to applicator. Admire, Alias, Actara, Assail, Calypso, Clutch: Maximum of 2 applications of product from this group per season. Repeated use may result in mite outbreaks. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Mites	• Kanemite 15 SC (20) • Nexter (21) • Envidor 240 SC (23) • Acramite 50 WS (UN)	Monitor for mites. Spray if more than 10 mites per leaf are observed or at first sign of leaf bronzing.
Japanese beetle	• Imidan 70-WP Instapak (1) • Calypso 480 SC (4) • Exirel (28)	This is a sporadic pest in Ontario that can cause economic damage, especially in young plantings of Honeycrisp. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Altacor: Suppression only at 285 g/ha. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Buffalo treehopper	Follow clean cultivation practices or remove legumes from cover crop.	
Phytophthora collar rot	• Ridomil Gold 480 SL (4)	
Root lesion nematode	See <i>Nematodes</i> , page 231.	

Table 3-7. Products Used on Apples

Use this table as a guide, but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between when you apply the pesticide and when you work in the treated crop without protective equipment.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Products used to control or suppress insects and mites						
Acramite 50 WS	27925	bifenazate	UN	7 days	12 hours	1
Actara 25 WG	28408	thiamethoxam	4A	60 days	12 hours	2
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	2
Agri-Mek 1.9% EC	24551	abamectin	6	28 days	12 hours	1
Alias 240 SC	28475	imidacloprid	4A	7 days	24 hours	2
Altacor	28981	chlorantraniliprole	28	5 days	12 hours	3 (max. 645 g/ha)
Ambush 500 EC	14882	permethrin	3	7 days	when dry	—
Apollo SC	21035	clofentezine	10	petal fall ¹	12 hours	1
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ² /48 hours ³ / 6 days ⁴	4
Beleaf 50 SG	29796	flonicamid	9C	21 days	12 hours ² /48 hours ⁴	3 (max. 480 g/ha)
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Calypso 480 SC	28429	thiacloprid	4A	30 days	12 hours	3 (max. 875 mL/ha)
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)
Confirm 240 F	24503	tebufenozide	18	14 days	12 hours	4
Cyd-X	30120	<i>Cydia pomonella</i> granulovirus	NC	0 days	12 hours	—
Decis 5 EC	22478	deltamethrin	3	1 day	12 hours	3
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	14 days	4 days	—
Diazinon 500 E	11889	diazinon	1B	14 days	4 days	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust SC	30382	spinosad	5	7 days	when dry	3/7 ⁵
Envior 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4 (max. 4.5 L/ha)
Foray 48BA	24978	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
GF-120 Fruit Fly Bait	28336	spinosad bait	5	—	when dry	10
Imidan 70-WP Instapak	29064	phosmet	1B	14 days	7 days ⁶ /14 days ⁶ / 30 days ⁴	5
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	2 (max. 2 L/ha)
Kanemite 15 SC	28641	acequinocyl	20B	14 days	12 hours ² /5 days ⁴	2 (max. 4.1 L/ha)

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U/UN = Mode of action has not been determined.

— = Information is not specified on the product label.

⁴ Personal protective equipment required for certain activities. See label.

¹ Apply no later than 14 days after petal fall.

² General re-entry.

³ Contact and scouting activities.

⁴ Hand thinning.

⁵ Maximum 3 foliar applications per year for obliquebanded leafroller or 7 trunk applications per year for apple clearwing moth.

⁶ Pick-your-own harvest.

⁷ Preharvest interval is 7 days when used for insect pests and 75 days when used for thinning.

⁸ Maximum of 2 applications per codling moth generation.

⁹ Hand harvest.

¹⁰ Formerly Group 18.

Table 3-7. Products Used on Apples (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Lannate Toss-N-Go	10868	methomyl	1A	8 days	12 hours ² /5 days ⁴	1
Malathion 25 W	14656	malathion	1B	3 days	12 hours	—
Malathion 85 E	8372	malathion	1B	3 days	12 hours	2
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.83 L/ha
Nexter	25135	pyridaben	21	25 days	24 hours	2
Perm-Up	28877	permethrin	3	7 days	12 hours	—
Pounce 384 EC	16688	permethrin	3	7 days	when dry	—
Purespray Green Spray Oil 13 E	27666	mineral oil	NC	—	12 hours	—
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	2
Ripcord	30316	cypermethrin	3	7 days	12 hours	2
Sevin XLR	27876	carbaryl	1A	11 days/75 days ⁷	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success	26835	spinosad	5	7 days	when dry	3
Superior 70 Oil	9542 14981	mineral oil	NC	—	12 hours	1 (full rate)
Surround WP	27469	kaolin	NC	0 days	12 hours	—
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Virosoft CP4	26533	<i>Cydia pomonella</i> granulovirus	NC	—	12 hours	4 ⁸
Vydate L	17995	oxamyl	1A	non-bearing only	24 hours	3
Products used for disease control or suppression						
Aliette	27688	fosetyl al	33	30 days	when dry	3
Allegro 500 F	27517	fluazinam	29	28 days	24 hours ² /3 days ⁴	9
Apogee	28042	prohexadione calcium	NC	45 days	12 hours	4 (max. 5.4 kg/ha)
Bio-Save 10 LP	29673	<i>Pseudomonas syringae</i>	NC	postharvest	—	1
Bloomtime Biological FD	28436	<i>Pantoea agglomerans</i>	NC	0 days	4 hours	2
Blossom Protect	30552	<i>Aureobasidium pullulans</i>	NC	0 days	when dry	5
Buran	30601	garlic powder	U	0 days	when dry	—
Copper 53 W	9934	tri-basic copper sulphate	M	30 days	48 hours	3
Dithane DG	29221	mancozeb	M	45 days	12 hours	—
Ferbam 76 WDG	20136	ferbam	M	7 days	12 hours	—
Flint	30619	trifloxystrobin	11	14 days	12 hours ² /4 days ⁴	4 (max. 840 g/ha)
Folpan 80 WDG	27733	folpet	M	—	24 hours	6

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U/UN = Mode of action has not been determined.

— = Information is not specified on the product label.

* Personal protective equipment required for certain activities. See label.

¹ Apply no later than 14 days after petal fall.

² General re-entry.

³ Contact and scouting activities.

⁴ Hand thinning.

⁵ Maximum 3 foliar applications per year for obliquebanded leafroller or 7 trunk applications per year for apple clearwing moth.

⁶ Pick-your-own harvest.

⁷ Preharvest interval is 7 days when used for insect pests and 75 days when used for thinning.

⁸ Maximum of 2 applications per codling moth generation.

⁹ Hand harvest.

¹⁰ Formerly Group 18.

Table 3-7. Products Used on Apples (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Fontelis	30331	penthiopyrad	7	28 days	12 hours	4 (max. 4.5 L/ha)
Granuflo T	30548	thiram	M	1 days	24 hours	—
Inspire Super	30827	difenoconazole + cyprodinil	3+9	14 days	12 hours	4
Kasumin 2L	30591	kasugamycin	24	90 days	12 hours	4
Kumulus DF	18836	sulphur	M	1 day	24 hours	8
Luna Tranquility	30510	fluopyram + pyrimethanil	7+9	14 days	12 hours	4 (max. 3.2 L/ha)
Maestro 80 DF	26408	captan	M	7 days	48 hours	—
Manzate Pro-stick	28217	mancozeb	M	45 days	24 hours	—
Mertect SC	13975	thiabendazole	1	postharvest	—	—
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Nova 40 W	22399	myclobutanil	3	14 days	when dry	6
Penncozeb 75 DF Raincoat	30241	mancozeb	M	45 days	24 hours	—
Polyram DF	20087	metiram	M	45 days	12 hours	—
Pristine WG	27985	boscalid + pyraclostrobin	7+11	5 days	when dry ² / 5 days ⁹ /12 days ⁴	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	non-bearing only	12 hours	2
Scala SC	28011	pyrimethanil	9	14 days	12 hours ² /24 hours ⁴	4
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Sovran	26257	kresoxim-methyl	11	30 days	48 hours	4
Streptomycin 17	10305	streptomycin sulphate	25 ¹⁰	50 days	24 hours ² /7 days ³ / 14 days ⁴	3
Supra Captan 80 WDG	24613	captan	M	7 days	48 hours	—
Syllit 400 FL	28351	dodine	U12	7 days	48 hours	2
Thiram 75 WP	27556	thiram	M	1 day	24 hours	—
Vangard 75 WG	25509	cyprodinil	9	0 days	12 hours	2

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U/UN = Mode of action has not been determined.
 — = Information is not specified on the product label.

* Personal protective equipment required for certain activities. See label.

¹ Apply no later than 14 days after petal fall.

² General re-entry.

³ Contact and scouting activities.

⁴ Hand thinning.

⁵ Maximum 3 foliar applications per year for obliquebanded leafroller or 7 trunk applications per year for apple clearwing moth.

⁶ Pick-your-own harvest.

⁷ Preharvest interval is 7 days when used for insect pests and 75 days when used for thinning.

⁸ Maximum of 2 applications per codling moth generation.

⁹ Hand harvest.

¹⁰ Formerly Group 18.

Notes on Apple Insects

Use the information in the following notes to assist with choosing the best product for the pest complex present. Consider the life stage present and resistance management strategies, as well as the activity of each

product to pests and beneficials. See Table 3-8. *Activity of Petal Fall Insecticides Against Orchard Pests*, page 53, Table 3-9. *Activity of Miticides Registered on Apple and/or Pear in Ontario*, page 53, Table 3-10. *Activity of Insecticides and Miticides on Apple Pests*, page 54, and Table 3-11. *Toxicity of Pesticides to Mite and Aphid Predators*, page 56.

Table 3-8. Activity of Petal Fall Insecticides Against Orchard Pests

Use insecticides only for insect listed on the product label for the crop and for the insect. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Insecticide	Group	Obliquebanded leafroller	Oriental fruit moth	Codling moth (eggs)	Plum curculio	Mullein bug	Tentiform leafminer	Japanese beetle	European apple sawfly
Actara 25 WG	4A	—	—	—	✓*	✓*	✓*	—	—
Admire 240 F	4A	—	—	—	—	✓*	✓*	—	—
Alias 240 SC	4A	—	—	—	—	✓*	✓*	—	—
Assail 70 WP	4A	—	✓*	—	✓*	✓*	✓*	✓	✓*
Calypso 240 SC	4A	—	✓*	—	✓*	✓*	✓*	✓*	✓*
Clutch 50 WDG	4A	—	✓s*	—	✓*	—	✓*	—	—
Delegate WG	5	✓*	✓*	—	✓s*	—	✓*	—	—
Entrust SC	5	✓*	—	—	—	—	✓	—	—
Success	5	✓*	—	—	—	—	✓	—	—
Bioprotec CAF	11	✓*	—	—	—	—	—	—	—
Dipel 2X DF	11	✓*	—	—	—	—	—	—	—
Foray 48BA	11	✓*	—	—	—	—	—	—	—
Rimon 10 EC	15	✓	✓*	✓*	—	—	—	—	—
Intrepid 240 F	18	✓*	✓*	—	—	—	✓*	—	—
Altacor	28	✓*	✓*	—	—	—	✓*	✓s*	✓*
Exirel	28	✓*	✓*	—	✓*	—	✓*	✓*	✓*

✓ = Has activity on the pest. s = Suppression. * (shaded area) = The pest is listed on the product label for control or suppression.

— = Pest is not registered for this product, or product does not have activity at this timing.

Table 3-9. Activity of Miticides Registered on Apple and/or Pear in Ontario*

Product	Target species	Life stage(s) affected	Preferred timing	Comments on knock-down
Acramite 50 WS	European red mite (apple) two-spotted spider mite (apple)	nymphs, adults	postbloom	rapid
Agri-Mek 1.9% EC	European red mite two-spotted spider mite pear rust mite (pear)	nymphs	within 21 days of petal fall	rapid
Apollo SC	European red mite two-spotted spider mite	primarily eggs, newly hatched nymphs	egg stage, before >3 active mites per leaf, no later than 14 days after petal fall	slow activity
Envidor 240 SC	European red mite two-spotted spider mite apple rust mite (apple) pear rust mite (pear)	eggs, nymphs, adult females	postbloom only	slow activity
Kanemite 15 SC	European red mite two-spotted spider mite	all life stages	postbloom	rapid
Nexter	European red mite (ERM) apple rust mite (ARM) two-spotted spider mite (TSSM) pear rust mite (PRM) (pear)	nymphs and adults of ERM, ARM and PRM nymphs of TSSM no effect on eggs	summer	rapid
Purespray Green Spray Oil 13 E	European red mite	overwintering eggs, some nymphs	half-inch green to tight cluster prior to hatch	smothers eggs
Superior 70 Oil	European red mite	overwintering eggs, some nymphs	half-inch green to tight cluster prior to hatch	smothers eggs

* Registered for use on apple or pear unless indicated otherwise. Use established thresholds to time applications. Miticides are most effective when applied alone, using recommended rates and water volumes. Apply each miticide only once per season to delay the development of resistance.

Table 3-10. Activity of Insecticides and Miticides on Apple Pests

Use products only for pests listed on the product label for the crop and for the pest. The information provided in this table is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Insecticide	Plum curculio	European apple sawfly	Oriental fruit moth	Spring-feeding caterpillar	Obliquebanded leafroller	Tentiform leafminer	San Jose scale	Codling moth	Mullein bug	Tarnished plant bug	White apple leafhopper	Potato leafhopper	Rosy apple aphid	Green apple aphid	Woolly apple aphid	Apple maggot	Leafcurling midge	European red mite	Two-spotted spider mite	Apple rust mite	Dogwood borer	Apple clearwing moth	Japanese beetle	Brown marmorated stink bug
Acramite 50 WS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3*	4*	0	0	0	0	0
Actara 25 WG ¹	3*	2	1	—	0	3*	0	1	3*	3	4	4	4*	4	—	2	—	0	0	0	—	—	1	3*
Admire 240 F ¹	—	—	—	—	—	4*	2	—	3*	1	4*	4*	4*	4*	2	2	—	0	0	0	—	—	1	2
Alias 240 SC ¹	—	—	—	—	—	4*	2	—	3*	1	4*	4*	4*	4*	2	2	—	0	0	0	—	—	1	2
Agri-Mek 1.9% EC	—	—	—	—	—	4* ES	—	—	—	—	3	3	—	—	—	—	—	3* ES	3* ES	3 ES	—	—	—	1
Altacor	1	4*	4*	4*	4*	4*	1	4*	—	1	2*	—	1	1	—	2*	—	0	0	0	3*	—	2*	1
Ambush 500 EC ¹	2*	3	4	3*	1* R	3*	1	2*	2*	3*	3*	3	2	2	1	3*	—	0	0	0	3*	—	3	2
Apollo SC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3* ES	2* ES	1 ES	0	0	0	0
Assail 70 WP ¹	3*	3*	4*	3*	1	4*	3	3*	3*	2	4*	4*	4*	4*	2	4*	2	0	0	0	—	—	4	3
Beleaf 50 SG	—	—	—	—	—	—	—	—	—	3	—	—	3*	3*	2*	—	—	0	0	0	—	—	—	1
Bioprotect CAF	0	—	1	3	3*	0	—	1	—	0	0	0	0	0	—	0	—	0	0	0	—	—	—	—
Calypso 480 SC ¹	4*	4*	4*	—	1	4*	2	3*	3*	3	4*	4*	4*	4*	2	3*	—	0	0	0	—	—	4*	2
Closer SC ¹	—	—	—	—	—	—	3*	—	—	—	—	—	3*	3*	2*	—	3	—	—	—	—	—	—	—
Clutch 50 WDG ¹	4*	—	3*	1	1	4*	—	2*	—	—	4*	4*	4*	4*	—	—	—	0	0	0	—	—	2	3*
Confirm 240 F	0	—	3 ES	3	3* R	3*	0	3*	—	0	0	0	0	0	—	0	—	0	0	0	—	—	—	1
Decis 5 EC ¹	1	3	3*	3*	2* R	3*	1	3*	1*	3	4*	4	3*	1*	1	3	2*	0	0	0	—	—	—	—
Delegate WG	2*	—	4*	4*	4*	4*	—	4*	—	—	—	—	0	0	—	2*	3	0	0	0	3*	1*	—	1
Diazinon 50 WSP	2	—	3	2*	2	1*	3*	2*	4*	3	1	1	4*	3*	4*	2*	3*	2*	2*	2*	—	—	2	1
Dipel 2X DF	0	—	1	3	3*	0	—	1	—	0	0	0	0	0	—	0	—	0	0	0	—	—	—	—
Entrust SC	1	—	1	4*	4*	3	—	2*	—	0	0	0	0	0	—	2	—	0	0	0	—	4*	—	—
Envirod 240 SC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4*	4*	4*	0	0	0	0
Exirel	4*	4*	4*	4*	4*	4*	—	4*	—	3	3*	—	3*	3*	—	3*	—	0	0	0	—	—	3*	—

0 = Not effective. 1 = Reduction in damage. 2 = Suppression. 3 = Good control with some limitations. 4 = Excellent control.

ES = Early season applications only. R = Resistant. — = Information is unavailable. * (shaded area) = The pest is listed on the product label for control or suppression.

¹ May cause mite flare-ups.

Ratings are based on moderate insect or mite pressure. Heavy infestations may require either higher dosage or shorter intervals, or both. Efficacy may be affected by rate of insecticide used, as well as coverage, timing and residual of the product. In some orchards, resistance may cause control failures when present. See *Pest Resistance to Fungicides, Insecticides and Miticides*, page 257. Products must be applied at proper timings and label rates for each pest. Consult label or apple calendar for this information.

Adapted from *Cornell Pest Management Guidelines for Tree Fruit* and the *Pennsylvania Tree Fruit Production Guide*.

Table 3-10. Activity of Insecticides and Miticides on Apple Pests (cont'd)

Insecticide	Plum curculio	European apple sawfly	Oriental fruit moth	Spring-feeding caterpillar	Obliquebanded leafroller	Tentiform leafminer	San Jose scale	Codling moth	Mullein bug	Tarnished plant bug	White apple leafhopper	Potato leafhopper	Rosy apple aphid	Green apple aphid	Woolly apple aphid	Apple maggot	Leafcurling midge	European red mite	Two-spotted spider mite	Apple rust mite	Dogwood borer	Apple clearwing moth	Japanese beetle	Brown marmorated stink bug
Foray 48 BA	0	—	1	3	3*	0	—	1	—	0	0	0	0	0	—	0	—	0	0	0	—	—	—	—
Imidan 70-WP Instapak	4*	3	3 R	3*	2* R	1*	1*	3* R	—	2*	1	1	2*	2*	1	3*	1	—*	—*	—	—	—	3*	1
Intrepid 240 F	0	—	3* ES	3	3* R	3*	0	3*	—	0	0	0	0	0	—	0	—	0	0	0	—	—	—	1
Kanemite 15 SC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4*	4*	—	0	0	0	0
Lannate Toss-N-Go	2	2	3	3	3*	3*	2	3*	—*	4	3*	3	2*	2*	1	2	—	0	0	0	—	—	—	3*
Malathion 85 E	3*	3	3	2	1	1	—*	3*	—	1	1	1	2*	3*	3*	2	—	—*	—*	—	—	—	—	2*
Matador 120 EC ¹	2*	3	3	3*	2* R	3*	1	3*	—	3*	4*	4	3*	2*	1*	3	2*	0	0	0	—	—	3	2
Movento 240 SC	—	—	—	—	—	—	4*	—	—	—	—	—	4*	4*	4*	—	3	0	0	0	—	—	—	—
Nexter	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	3*	2*	3*	0	0	0	0
Perm-Up ¹	2*	3	4	3*	1* R	3*	1	2*	2*	3*	3*	3	2	2	1	3*	—	0	0	0	3*	—	3	2
Pounce 384 EC ¹	2*	3	4	3*	1* R	3*	1	2*	1*	3*	3*	3	2	2	1	3*	—	0	0	0	3*	—	3	2
Purespray Green Spray Oil 13 E	—	—	1	—	—	1	4*	1	—	—	—	—	2	2	1	—	—	4*	2	3	—	—	—	—
Rimon 10 EC	—	—	4*	4	4	4	—	4*	—	3	2	2	—	—	—	—	—	0	0	0	3*	3*	—	1
Ripcord ¹	3*	3	3	3*	1 R	3*	1	2*	1*	3*	1*	—	2	2	—	2*	2*	0	0	0	—	—	3	—
Sevin XLR	2*	2	3 R	2*	1	2*	1*	2*	—	2*	4*	4	1	1	1*	2*	—	0	0	1*	—	—	4	2
Silencer 120 EC ¹	2*	3	3	3*	2* R	3*	1	3*	—	3*	4*	4	3*	2*	1*	3	2*	0	0	0	—	—	3	2
Success	1	—	1	4*	4*	3	—	2	—	0	0	0	0	0	—	2	—	0	0	0	—	4*	—	—
Superior 70 Oil	—	—	—	—	—	—	4*	—	—	—	—	—	2	2	—	—	—	4*	—	—	—	—	—	—
Surround WP	2*	2*	1*	1	1*	1	2	1* ES	—	1*	1*	2*	1	1	—	2*	—	2	0	0	—	—	1	2
Up-Cycle 2.5 EC ¹	3*	3	3	3*	1* R	3*	1	2*	1	3*	1*	—	2	2	—	2*	2*	0	0	0	—	—	3	—
Vydate L	0	—	0	—	1*	3*	1	0	—	2*	3*	3*	3*	2*	1*	0	—	2*	3*	3*	—	—	—	3

0 = Not effective. 1 = Reduction in damage. 2 = Suppression. 3 = Good control with some limitations. 4 = Excellent control.

ES = Early season applications only. R = Resistant. — = Information is unavailable. * (shaded area) = The pest is listed on the product label for control or suppression.

¹ May cause mite flare-ups.

Ratings are based on moderate insect or mite pressure. Heavy infestations may require either higher dosage or shorter intervals, or both. Efficacy may be affected by rate of insecticide used, as well as coverage, timing and residual of the product. In some orchards, resistance may cause control failures when present. See *Pest Resistance to Fungicides, Insecticides and Miticides*, page 257. Products must be applied at proper timings and label rates for each pest. Consult label or apple calendar for this information.

Adapted from *Cornell Pest Management Guidelines for Tree Fruit* and the *Pennsylvania Tree Fruit Production Guide*.

Table 3-11. Toxicity of Pesticides to Mite and Aphid Predators

Product	<i>Stethorus</i> adults	<i>Stethorus</i> larvae	<i>Typhlodromus</i> <i>pyri</i>	<i>Amblyseius</i> <i>fallacis</i>	<i>Zetzelia</i> <i>malii</i>	<i>Aphidoletes</i>	Ladybugs	Minute pirate bugs	Lacewings	Fly and wasp parasitoids
Insecticides										
Actara 25 WG	VT	VT	ST	ST	NT	MT	MT	MT	MT	VT
Admire 240 F	MT	MT	ST	ST	NT	ST	MT	MT	MT	MT
Alias 240 SC	MT	MT	ST	ST	NT	ST	MT	MT	MT	MT
Altacor	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Ambush 500 EC	VT	VT	VT	VT	MT	ST	MT	MT	MT	VT
Assail 70 WP	MT	MT	ST	MT	NT	MT	MT	MT	MT	VT
Beleaf 50 SG	—	—	—	—	—	—	—	—	—	—
Bioprotec CAF	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Calypso 480 SC	MT	MT	NT	NT	NT	ST	MT	MT	MT	VT
Clutch 50 WDG	VT	VT	ST	ST	NT	MT	MT	MT	MT	VT
Confirm 240 F	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYD-X	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Decis 5 EC	VT	VT	VT	VT	MT	MT	VT	MT	VT	VT
Delegate WG	ST	ST	MT	MT	ST	ST	ST	ST	ST	MT
Diazinon 50 WSP	MT	MT	MT	MT	ST	VT	MT	ST	MT	VT
Dipel 2X DF	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Entrust SC	NT	NT	ST	ST	NT	NT	NT	NT	NT	ST
Exirel	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Foray 48BA	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Imidan 70-WP Instapak	ST	ST	NT	NT	NT	MT	MT	MT	MT	VT
Intrepid 240 F	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Lannate Toss-N-Go	MT	MT	VT	VT	MT	VT	VT	MT	VT	VT
Malathion 25 W/85 E	ST	ST	NT	NT	NT	ST	MT	ST	ST	MT
Matador 120 EC	VT	VT	VT	VT	MT	VT	VT	VT	VT	VT
Movento 240 SC	ST	ST	NT	NT	NT	ST	ST	ST	ST	—
Perm-Up	VT	VT	VT	VT	MT	ST	MT	MT	MT	VT
Pounce 384 EC	VT	VT	VT	VT	MT	ST	MT	MT	MT	VT
Rimon 10 EC	MT	VT	NT	NT	NT	—	VT	MT	VT	VT
Sevin XLR	VT	VT	MT	MT	MT	VT	MT	MT	MT	VT
Silencer 120 EC	VT	VT	VT	VT	MT	VT	VT	VT	VT	VT
Success	NT	NT	ST	ST	NT	NT	NT	NT	NT	ST
Surround WP	MT	MT	MT	MT	MT	MT	MT	—	ST	MT
Virosoft CP4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Miticides										
Acramite 50 WS	NT	NT	MT	MT	MT	ST	NT	NT	NT	—
Agri-Mek 1.9% EC	MT	MT	MT	MT	ST	ST	ST	ST	ST	—
Apollo SC	NT	NT	ST	ST	ST	NT	NT	NT	NT	—
Envior SC	MT	MT	NT	NT	NT	—	—	—	—	—
Kanemite 15 SC	ST	ST	ST	ST	ST	—	—	—	—	—

NT = Non toxic. ST = Slightly toxic. MT = Moderately toxic. VT = Very toxic. — = No information is available.

Only registered products with toxicity data available are listed in this table. Consult label or manufacturer for more information.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Table 3-11. Toxicity of Pesticides to Mite and Aphid Predators (cont'd)

Product	<i>Stethorus</i> adults	<i>Stethorus</i> larvae	<i>Typhlodromus</i> <i>pyri</i>	<i>Amblyseius</i> <i>fallacis</i>	<i>Zetzellia</i> <i>mall</i>	<i>Aphidoletes</i>	Ladybugs	Minute pirate bugs	Lacewings	Fly and wasp parasitoids
Nexter	MT	MT	VT	VT	MT	MT	MT	MT	MT	—
Purespray Green Spray Oil 13 E	ST	ST	MT	MT	ST	ST	ST	ST	ST	—
Superior 70 Oil	ST	ST	MT	MT	ST	ST	ST	ST	ST	—
Vydate L	MT	MT	VT	VT	VT	MT	MT	VT	VT	VT
Fungicides										
Dithane DG	ST	ST	MT	MT	ST	—	—	—	—	—
Flint	ST	ST	NT	NT	NT	—	—	—	—	—
Granuflo T	ST	ST	ST	ST	—	—	—	—	—	—
Inspire Super	ST	ST	NT	NT	NT	—	—	—	—	—
Kumulus DF	MT	MT	MT	MT	ST	—	—	—	—	—
Maestro 80 DF	ST	ST	ST	ST	ST	ST	—	—	—	—
Manzate Pro-Stick	ST	ST	MT	MT	ST	—	—	—	—	—
Microscopic Sulphur	MT	MT	MT	MT	ST	—	—	—	—	—
Microthiol Disperss	MT	MT	MT	MT	ST	—	—	—	—	—
Nova 40 W	ST	ST	NT	NT	NT	—	—	—	—	—
Penncozeb 75 DF Raincoat	ST	ST	MT	MT	ST	—	—	—	—	—
Polyram DF	ST	ST	MT	MT	ST	—	—	—	—	—
Pristine WG	ST	ST	NT	NT	NT	—	—	—	—	—
Sovran	NT	NT	NT	NT	NT	—	—	—	—	—
Supra Captan 80 WDG	ST	ST	ST	ST	ST	ST	—	—	—	—
Syllit 400 FL	—	—	ST	ST	—	ST	—	—	—	—
Thiram 75 WP	ST	ST	ST	ST	—	—	—	—	—	—
Vanguard 75 WG	NT	NT	NT	NT	NT	—	—	—	—	—

NT = Non toxic. ST = Slightly toxic. MT = Moderately toxic. VT = Very toxic. — = No information is available.

Only registered products with toxicity data available are listed in this table. Consult label or manufacturer for more information.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Notes on Apple Diseases

Apple scab

Primary infection periods

Once the tree breaks dormancy and green tissue is present, a primary infection occurs if the following conditions are met:

1. mature ascospores are present in leaf litter in the orchard
2. weather conditions favour ascospore discharge and infection

3. fungicide protection is inadequate to prevent infections

Mature ascospores are always present in infected overwintering leaves at bud break. The number of ascospores present depends on the amount of inoculum in the overwintering leaves. The rate at which ascospores mature in the overwintering leaves on the orchard floor is mainly determined by temperature.

Researchers at Cornell University have developed a model that relates temperature to ascospore maturation. The model is expressed in degree-days Celsius (DDC) and allows you to predict the percentage of the season's ascospores that have matured. For further information,

see Figure 3-2. *Cumulative Percentage of Ascospores Matured at Various Degree-Day Accumulations*, page 58 and Appendix B: *Degree-Day Modeling*, page 291. Daily accumulated degree-days are calculated as follows:

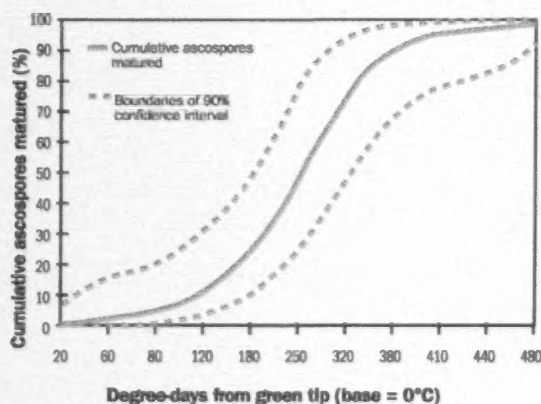
$$\text{DDC} = \frac{(\text{Daily max } ^\circ\text{C}) + (\text{Daily min } ^\circ\text{C})}{2} - \text{min base } ^\circ\text{C}$$

The minimum base temperature for development of apple scab is 0°C.

For example, on a day with a high of 10°C and a low of 2°C, the accumulated degree-days are 6 DDC. If either of the daily temperatures is below 0°C, i.e., a negative number, then use a value of zero for that temperature. Begin degree-day accumulations at bud break, which is defined as the day on which at least 50% of the fruit buds on McIntosh are between silver tip and green tip.

Use the degree-day accumulations to estimate the percentage of mature ascospores from the central curve in Figure 3-2. *Cumulative Percentage of Ascospores Matured at Various Degree-Day Accumulations*, below. The upper and lower curves are the upper and lower 90% confidence limits around the estimates on the graph. The estimate should fall within this range 90% of the time.

Figure 3-2. Cumulative Percentage of Ascospores Matured at Various Degree-Day Accumulations



Two points of particular interest on this graph are:

- At 125 DDC, there is a rapid maturation of ascospores that indicate higher risk of infections.
- At 418 DDC, over 95% of the ascospore supply should be depleted if sufficient rain has occurred. This marks the end of the primary infection season. With this model, growers can obtain a site-specific forecast

of ascospore maturity and discharge for their own orchard(s).

Ascospores are released when there is rain to wet the pseudothecia in the dead leaves. Most of the available mature spores are discharged within 2 hours after the start of rain. Ascospore release is strongly light-dependent and only a small percentage of available ascospores are released at night from 7:00 p.m. to 8:00 a.m. Eastern Daylight Savings Time (EDST).

In **low-inoculum** orchards, ascospores are not released to any significant extent during night-time hours. In an orchard where the ascospore inoculum is high, although the percentage of ascospores released is small at night, the total number of ascospores released is large and can result in a significant primary scab infection. If scab was present in the orchard the previous season, consider the orchard to have high inoculum.

In a low-inoculum orchard, calculate the length of the wetting period using the following method:

- When rain begins during the day, between 8:00 a.m. and 7:00 p.m. EDST, count the hours of leaf wetness from when the first hour rain was recorded until the leaves are dry.
- When rain begins at night, between 7:00 p.m. and 8:00 a.m. EDST, count the hours of leaf wetness from 8:00 a.m. in the morning until the leaves are dry.

For a high-inoculum orchard, calculate the length of the wetting period from the start of the rain until the leaves are dry, regardless of the time of day. In high-inoculum orchards if a rain event starts during the day, continue counting the hours of leaf wetness even after nightfall.

Rainfall is needed for the release of ascospores and the leaves and fruit must be wet for infection to occur. The length of the wetting period required for infection varies with temperature. The relationship between hours of wetting and temperature is outlined in Table 3-12. *Relationship of Temperature and Moisture to Apple Scab Infection*, page 59.

Once the length of the wetting period is determined, calculate the average temperature during this interval and check Table 3-12. *Relationship of Temperature and Moisture to Apple Scab Infection*, page 59, to see if leaves were wet long enough for an infection to occur.

Once a primary infection occurs and primary lesions are present, then secondary infections can occur. Initially lesions can be very difficult to see. As a result, scouting and maintaining adequate fungicide coverage are very important.

Secondary infection periods

Secondary scab infections occur when splashing rain spreads conidia, developed from primary scab lesions, on leaves. Secondary infections only occur if moisture from rain is present long enough at a given temperature. Since secondary infections can occur day or night, calculate from the beginning of the wetting period, regardless of time of day.

Effect of intermittent rain and dew on infection periods

Periods of dew or high humidity (over 90%) also contribute to a wetting period, but are significant only if preceded by rain. Add together wet periods caused by intermittent rain to determine the length of an infection period, unless wet periods are separated by 10 hours or more of dry, sunny weather.

Table 3-12. Relationship of Temperature and Moisture to Apple Scab Infection

Average temp. (°C)	Minimum number of hours of leaf wetness required	
	Primary season (ascospore infection)	Secondary season (conidia infection)
1	40	37
2	34	33
4	27	26
5	21	23
6	18	20
7	15	17
8	13	15
9	12	13
10	11	12
11	9	10
12	8	9
13	8	9
14	7	9
15	7	9
16	6	9
17	6	8
18	6	8
19	6	8
20	6	7
21	6	7
22	6	7
23	6	8
24	6	9
25	8	11
26	11	14

Adapted from: Stensvand, Gadoury, Amundsen, Semb and Seem, 1997
Phytopathology 87: 1046-1053.

Fruit infection

As the fruit matures, it takes a longer wetting period for infection by apple scab to occur. Refer to the OMAF website at www.ontario.ca/cropIPM or OMAF Publication 310, *Integrated Pest Management for Apples*.

Reducing apple scab inoculum

While growers have little control over weather conditions, they can reduce inoculum and ensure adequate fungicide protection. The following methods will reduce inoculum in orchards.

The application of urea (45 kg of agricultural urea per 1,000 L of water/ha) to the orchard floor after about 95% leaf drop (November) or in the spring (April) before bud break reduces the number of ascospores. The urea works by directly inhibiting the development of ascospores, and stimulating the growth of naturally occurring organisms that are antagonistic toward the apple scab fungus. In most years, the spring treatment is more effective and results in fewer leaf and fruit infections. However, when snow cover remains until bud break, there is little time for the urea to work, and the treatment is less effective.

Shredding overwintering leaves can also reduce primary inoculum. Rake or blow leaves from under trees and shred them using a flail mower. Shredded leaves decay more quickly.

Management of apple scab with fungicides

Early season management

Management programs for primary apple scab infection are based on the timing and type of fungicide used. There are two general approaches. Apply fungicides as a protectant program before infection occurs, or apply fungicides after infection but before symptoms develop.

Fungicides are applied to expanding foliage before infection periods occur. Apply fungicides when conditions for infection are imminent. Begin fungicide programs between silver tip and green tip. From first cover until early August, apply fungicides at 10–14-day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues washed off by rain must be replaced. The exception to this is when using fungicides in the DMI group (Nova, Nustar, Inspire). Use a 5–7-day spray schedule regardless of rainfall. DMI fungicides are weak on fruit scab, so do not start a DMI program after bloom. Some fungicides are not readily washed off and the residues are redistributed by rainwater. See Table 3-13. *Characteristics of Apple Scab Fungicides*, page 61.

There are several different fungicide groups available for use in apples. See Table 10-2, *Fungicide/Bactericide Groups*, page 260. For more information on these fungicides, refer to OMAF Publication 310, *Integrated Pest Management for Apples*. For information on resistance management strategies with these products, refer to *Managing resistance to fungicides*, page 258.

Control of apple scab under adverse weather conditions

Several consecutive days of continually wet conditions and mild temperatures are common in the spring. These conditions encourage apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If there is concern about adequate protection, it is better to apply a protectant-type fungicide during a break in the rain than to not spray at all. Be sure to use a fungicide with good retention properties. For example, products with mancozeb such as Dithane, Manzate and Penncozeb have good retention activity.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit.

If an infection exists, scab lesions become visible on the foliage and fruit in about 9 days at 20°C or in about 14–21 days if the average temperatures are 12°C or lower. Once this occurs, avoid using fungicides with high potential for resistance (DMIs, strobilurins) and focus on protecting uninfected tissue from further infections.

Strong winds can hamper spray operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. You can also lower the spray trajectory into the wind to minimize drift, but take extra care to ensure the treetops get good spray coverage.

Secondary scab management

The end of primary season can be determined through use of the degree-day model. At 418 DDC, over 95% of the ascospores are mature, and after a significant rain all of the ascospores have been discharged for the season. After this point, wait 2 weeks and then check the trees for scab. It can take up to 14 days for lesions to appear after a scab infection period. Be sure to check the top of standard trees or anywhere else spray coverage may not have been adequate, such as a thick tree canopy.

If primary scab was controlled, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. If scab lesions are found, maintain a fungicide program for the remainder of the season.

Choosing a fungicide

Use the information in the following tables to assist with choosing the best product for the most likely diseases. Consider the history of the disease, resistance management strategies, as well as the activity of each product to diseases, and the weather. See Table 3-13, *Characteristics of Apple Scab Fungicides*, page 61, Table 3-14, *Activity of Fungicides on Apple Diseases*, page 62, and *Pest Resistance to Fungicides, Insecticides and Miticides*, page 257.

Table 3-13. Characteristics of Apple Scab Fungicides

Product	Protectant activity (pre-infection)	Post-infection activity (hours) ¹	Post-symptom activity	Retention (50 mm rain)	Redistribution (12 mm rain)
Dithane DG	VG	18-24	N	E	VG
Ferbam WDG	G	15-20	N	G	G
Flint	VG	48-72 ²	G	E	G
Granuflo T	F-G	15-20	N	F-G	F
Inspire Super	VG	48 ²	VG	VG	G
Kumulus DF	F	N	N	F-G	F-G
Maestro 80 DF	VG	18-24	N	VG	G
Manzate Pro-Stick	VG	18-24	N	E*	VG
Microscopic Sulphur	F	N	N	F-G	F-G
Microthiol Dispers	F	N	N	F-G	F-G
Nova 40 W	F	72-96 ²	G-VG	F*	F*
Penncozeb 75 DF Raincoat	VG	18-24	N	E	VG
Polyram DF	VG	18-24	N	E*	G
Scala SC	G	48-72	N	G	—
Sovran	VG	48-72 ²	G	E	F*
Supra Captan 80 WDG	VG	18-24	N	VG	G
Syllit 400 FL	VG	18-24	VG	VG	G
Thiram 75 WP	F-G	15-20	N	F-G	F
Vangard 75 WG	G	48-72	N	G	—

E = Excellent. VG = Very good. G = Good. F = Fair. N = None. Values followed by * are based on field observations. — = Indicates no information is available.

¹ Maximum post-infection activity is calculated from the start of the infection period.

² Post-infection activity of sterol inhibitor (Nova and Inspire Super) and strobilurin (Flint and Sovran) fungicides may be reduced in orchards where scab populations have shifted towards resistance.

Data is adapted from *Cornell Pest Management Recommendations for Commercial Tree Fruit Production* and work done by Szkolnik et al. (Geneva, NY) using conidia in greenhouse trials on Golden Delicious. The post-infection activity of these fungicides may not be adequate to control primary scab in commercial orchards. Do not rely solely on post-infection activity.

Newer products and formulations of some products have not been evaluated (e.g., Allegro 500 F, Fontelis, Luna Tranquility and Pristine WG). Contact the manufacturer for more information.

Table 3-14. Activity of Fungicides on Apple Diseases

Use fungicides only for the disease listed on the product label for the crop. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product or by the presence of resistant populations. See *Resistance management strategies by fungicide group and disease for Ontario fruit crops*, page 258.

Group	Fungicide	Apple scab	Powdery mildew	Rust	Black rot	Bitter rot	Sooty blotch	Fly speck
M	Copper 53 W	1	1	1	1	1	1 P	1 P
M	Kumulus DF	1 *	2 *	1	1	2	1	1
M	Microscopic Sulphur	1 *	2 *	1	1	2	1	1
M	Microthiol Disperss	1 *	2 *	1	1	2	1	1
M	Dithane DG	3 *	0	3 *	3	3	3	3
M	Manzate Pro-Stick	3 *	0	3 *	3	3	3	3
M	Penncozeb 75 DF Raincoat	3 *	0	3 *	3	3	3	3
M	Polyram DF	3 *	0	4 *	3	4	4	4
M	Supra Captan 80 WDG	3 *	0	0	3 *	2 *	2 *	2 *
M	Maestro 80 DF	3 *	0	0	1 *	2 *	3 *	3 *
M	Ferbam 76 WDG	1 *	0	2 P *	2 *	1 *	2 *	2 *
M	Folpan 80 WDG	2 *	—	—	2 *	—	2 *	2 *
M	Granuflo T	2 *	0	3 *	2 *	1 *	2 *	2 *
M	Thiram 75 WP	2 *	0	3 *	2 *	1 *	2 *	2 *
3+9	Inspire Super	4 *	2 *	4 *	0	0	3 *	3 *
3	Nova 40 W	3 *	4 *	4 *	0	0	0	0
7	Fontelis	4 *	3 *	2 *	—	—	—	—
7+9	Luna Tranquility	3 *	3 *	—	—	—	—	—
7+11	Pristine WG	4 *	3 *	2	3	3	3 *	3 *
9	Vanguard 75 WG	2 *	1 *	—	0	0	0	0
9	Scala SC	2 *	—	0	0	0	0	0
11	Sovran	4 *	4 *	2	2	2	4	3
11	Flint	4 *	4 *	2 *	3	2	4 *	3 *
29	Allegro 500 F	2 *	0	0	0	0	3 *	3 *
U12	Syllit 400 FL	3 *	1	2	1	0	1	1
NC	Purespray Green Spray Oil 13E	0	1 *	0	0	0	0	0

0 = No control. 1 = Poor control. 2 = Fair control. 3 = Good control, some limitations. 4 = Excellent control, few if any limitations.

— = Not registered for this disease, or information is unavailable. * (shaded area) = The pest is listed on the product label for control or suppression.

NC = Not classified by FRAC/IRAC, or group not indicated on product label.

U = Mode of action has not been determined.

P = Phytotoxic, causes russetting.

Source: Various extension publications, scientific journal articles and Plant Disease Management Reports (APS).

Thinning and Plant Growth Regulators

Chemical thinning of apples

Thinning of apples is a key step to annual cropping and increased fruit size. In young high-density orchards, this is increasingly important to make your investment profitable. In all orchards, proper thinning will:

- improve average fruit size and finish
- create more uniformity in the crop
- encourage return bloom and annual bearing

The objective of thinning is to reduce clusters to single fruitlets on most cultivars, preferably the king bloom fruitlet, and to adequately space fruit to every other bearing spur. An additional benefit of thinning is reduced probability of pest damage. Some pests are more likely to damage clustered fruit. As well, a well-thinned crop is more efficient to harvest, which reduces labour costs per bin.

Early thinning is important. Thinning near bloom or shortly afterward will increase average fruit size and maximize return bloom the next year. Late-summer thinning may improve fruit size and colour, and prevent limb breakage, but will not affect return bloom.

Grower experience is the best guide to thinning decisions, so it is important to document the previous thinning history including rates, conditions at time of application, and results. Other factors include:

- cultivars involved
- fruit sizes required
- strength of bloom
- bee activity
- weather conditions during pollination and following fruit set

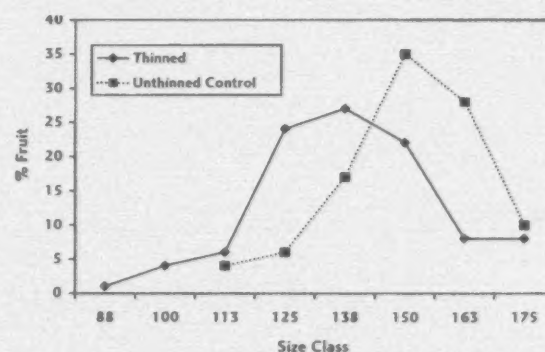
Fruit size distribution in the tree canopy

When you compare a well-thinned apple tree of any cultivar to a tree that is insufficiently thinned, several factors become obvious.

- Fruit size distribution within the canopy of both trees follows a normal distribution pattern. See Figure 3-3. *Thinning Effects on Fruit Size Distribution* on this page.
- Other factors being equal, the average fruit size from the thinned tree is greater than that of an unthinned tree.
- While adequate thinning typically reduces yield, the value of the thinned crop more than compensates for

any loss in yield provided the tree is not over-thinned. In other words, where the fruit volume of thinned and unthinned trees is similar, the thinned tree has fewer apples but they are of greater size and higher value. See Table 3-15. *Effect of Apple Fruit Size on Tray and Bin Requirements*, on this page for a comparison of fruit numbers of different size classes required to fill a standard apple bin. See Table 3-16. *Effect of Fruit Size in Relation to Crop Load*, page 64, to determine how much thinning is required.

Figure 3-3. Thinning Effects on Fruit Size Distribution



This figure shows how the distribution of fruit size classes is similar on thinned and unthinned Empire trees. Note that thinning pushes the size distribution to the larger size classes. There was less than 10% difference in total yield between the two treatments.

Table 3-15. Effect of Apple Fruit Size on Tray and Bin Requirements

Minimum fruit size			Tray size	Number of apples per bin ²
wt (g) ¹	Inch	mm		
102	2 1/4	57	196	3,920
114	2 3/8	60	175	3,500
123	2 1/2	64	163	3,260
133	2 5/8	67	150	3,000
145	2 3/4	70	138	2,760
160	2 7/8	73	125	2,500
177	3	76	113	2,260
200	3 1/8	79	100	2,000
227	3 1/4	83	88	1,760
250	3 3/8	85	80	1,600
278	3 1/2	89	72	1,440
313	3 5/8	92	64	1,280
357	3 3/4	95	56	1,120
417	3 7/8	98	48	960

¹ These values are approximate as fruit of the same diameter can differ in weight.

² 18-bushel bin capacity.

Table 3-16. Effect of Fruit Size in Relation to Crop Load

Minimum size		Number of apples required per tree for given tree density, desired yield and fruit size					
		Tree density (trees per acre)					
		272		500		1,000	
		Projected yield (bu/ac)					
inch	mm	400	600	500	750	750	1,250
2 ¼	57	320	480	218	327	163	272
2 ⅜	60	286	429	194	292	146	243
2 ½	64	266	400	181	272	136	226
2 ⅝	67	245	368	167	250	125	208
2 ¾	70	225	338	153	230	115	192
2 ⅞	73	204	306	139	208	104	174
3	76	185	277	126	188	94	157
3 ⅛	79	163	245	111	167	83	139
3 ¼	83	144	216	98	147	73	122
3 ⅜	85	131	196	89	133	67	111
3 ½	89	118	176	80	120	60	100
3 ⅝	92	105	157	71	107	53	89
3 ¾	95	92	137	62	93	47	78
3 ⅞	98	78	118	53	80	40	67

Steps in chemical thinning

1. **Is thinning needed?** Determine if and how much thinning is required by assessing potential crop load. Look carefully at the developing fruitlets, especially the sepals (or calyx leaves). Sepals on unpollinated blooms tend to stay open or bend back. Successful pollination and fruit set result in sepal movement and closure. See *Factors influencing response to thinning agents*, page 68.
2. **Which product(s) should be used?** This depends on the cultivar and stage of crop development. See *Chemicals available for thinning*, page 66, and Table 3-17. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 65.
3. **What water volume is needed?** High water volumes that wet the foliage to the point of runoff are recommended for chemical thinners, because the chemicals need to contact the fruitlets and spur leaves. The average tree on M.26 (3–3.5 m tall) at a density of 720 trees/ha may require more than 2 L of spray per tree to thoroughly wet the foliage at the time of the thinning. As the tree size becomes smaller and the number of trees per ha increases, the volume of canopy that must be sprayed may become less. Calibrate the sprayer and water volumes on small groups of trees to determine just how much water is required to thoroughly wet individual trees. See OMAF Factsheet, *Adjusting, Maintaining and Cleaning Airblast Sprayers*.
4. **When should thinners be applied?** Thinners should be applied when fruitlets reach the optimum size for thinning and when weather conditions will allow the maximum effectiveness (warm temperatures and calm winds are best). Measure 50–60 fruitlets of each cultivar. Select the 2 largest developing fruitlets (king bloom and next) from each of 25–30 randomly selected clusters. Measure the greatest diameter of each using Vernier or digital calipers, or a thinning template and determine the average for the sample. See Table 3-18. *Optimum Fruitlet Size for Chemical Thinning*, page 66, to determine the best timing for each cultivar.
5. **When should results be assessed?** It will take 7–10 days to see visual effects of the thinner. Brush your hand gently across the clusters to see how many will drop. Fruitlets that will drop will stop growing, and their stems turn yellow. To decide if a second thinner is needed, fruitlets can be tagged and measured at 3 and 7 days after application. If needed, the second application should be applied before fruitlets exceed 10–14 mm.

Be sure to leave a few trees unsprayed in each bloom, and assess them to compare the natural drop to the effects of your thinners.

Table 3-17. Suggested Rates for Chemical Thinning of Mature Apple Trees¹

Cultivar	NAA (ppm) ²	Sevin XLR (L/1,000 L water) ³	Sevin XLR + NAA (ppm/1,000 L water) ^{2,3}	MaxCel or Cilis Plus (g BA/ha) ⁴	Sevin XLR (L/1,000 L water) ^{2,3} + MaxCel or Cilis Plus (g BA/ha) ⁴
Ambrosia	---	1-1.5	---	50	---
Aurora Golden Gala™	---	1-1.5	---	75	1 + 50
Cameo	---	1	---	---	---
Cortland	5-10	---	1-2 + 2.5-5	---	---
Creston	---	0.5-1	---	---	---
Empire	7-10	1-1.5	1 + 2.5-4	50-100	1 + 50
Fuji	---	---	1-1.5 + 10-12	100-150	1-2 + 50-75
Gala	10-12	---	1 + 5-10	75-100	1-2 + 50
Gingergold	7-10	1-1.5	1 + 2.5-5	75	1 + 50
Golden Delicious, Wealthy	10-20	1-2	1 + 5-10	75-100	1-2 + 50
Golden Supreme	---	1	---	---	---
Goldrush	---	---	1 + 10	---	---
Honeycrisp	5	1-1.5	1 + 2.5	---	---
Idared	2-8	---	---	50-75	---
Jerseymac, VistaBella, Tydemans Red	5-10	1-1.5	---	---	---
Jonagold	---	1-1.5	---	50-75	---
Lodi, Melba, Quinte, Yellow Transparent	---	---	1 + 10-15	---	---
McIntosh, Early	---	---	1 + 5-10 ⁵	50-75	---
McIntosh, Non-spur	5-10	1-2	---	50	---
McIntosh, Spur-type	10-12	---	1-2 + 2.5-5	50-75	1 + 50
Paulared	12-15	1-1.5	1 + 10-15	75	1 + 50
Red Delicious	2-8	0.5-1.5	---	---	---
Red Delicious, Spur-type	5-10	---	1-2 + 5-10	---	---
Silken	---	1-1.5	---	---	---
Spartan, Russets	10-20	1-2	1 + 10-15	---	---
Spy, Mutsu/Crispin	5-10	0.5-1.5	---	---	---

--- = Treatment information not available.

¹ These rates are suggested for trees with a settled cropping history. Chemically thinning a first crop tree or immature trees is considered very risky.

² Sufficient water volumes must be used to thoroughly wet trees. See *Steps in chemical thinning*, page 64.

³ Sevin XLR is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl per litre.

1 L of Sevin XLR is roughly equivalent to 1 kg of Sevin 50 W. For actual amount of NAA, refer to the label.

⁴ Consult Table 3-19, *Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin*, page 66, to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective.

⁵ At petal fall.

Table 3-18. Optimum Fruitlet Size for Chemical Thinning

Cultivar	Diameter of largest fruitlets in cluster*
McIntosh	8–12 mm
Red Delicious	6.5–8 mm
Northern Spy	10–11 mm
Empire, Idared, Jonagold	8–12 mm
Gala, Golden Delicious, Fuji	8–12 mm

* Due to variability in fruit size, a sample of king fruitlets in 25–30 randomly selected clusters should be measured using a thinning template or Vernier calipers to determine the average.

Chemicals available for thinning

MaxCel or Cilis Plus (6-BA)

Product Name: MAXCEL or CILIS PLUS

Active ingredient: 1.9% 6-benzyladenine (6-BA)

Type of thinner: A growth regulator containing a cytokinin (6-BA) that promotes cell division.

How it works: Used for both fruit thinning and improving fruit size. Fruit size potential is increased due to increased cell division shortly after flowering in the early stages of fruit growth and development.

Rate: To increase fruit size, make 2–4 applications at 10–50 ppm, beginning at petal fall and repeating every 3–10 days. Some easy-to-thin cultivars may also be thinned. To thin fruit, apply at 75–200 ppm. See

Table 3-19. *Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin* on this page.

Application: Dilute MaxCel or Cilis Plus in 500–2,000 L of spray solution per ha. Uniform and thorough coverage is essential. Use enough water to wet the foliage just to the point of runoff. See Table 3-20. *Tank Concentration of MaxCel or Cilis Plus*, page 67.

Cultivar notes: Recommended for Empire, McIntosh, Idared, Gala and others; not effective on all cultivars. See Table 3-17. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 65.

Timing: For thinning, these products are most effective when fruitlets are 5–15 mm in diameter. To improve fruit size, begin applications at petal fall.

Repeat applications: Apply a maximum of 2 sprays per season for thinning, or 4 applications to improve fruit size.

Optimum conditions: Best results are obtained when temperatures greater than 20°C occur during and after application. Slow drying conditions are preferred (e.g., early morning).

Precautions: Preharvest interval is 86 days. Do not apply MaxCel or Cilis Plus in combination with NAA (naphthaleneacetic acid) either as a tank-mix or separate sprays during the same growing season. These combinations may result in pygmy fruit in Delicious and Fuji.

Table 3-19. Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin

Desired response ¹	Concentration of 6-BA (ppm) ²	Concentration of carbaryl (ppm) ²	Number of applications	Amount of MaxCel (L/1,000 L water/ha)	Amount of Sevin XLR (L/1,000 L water/ha)
Enhance size only ^{3,4}	10–50	—	2 to 4	0.5–2.5	—
Mild thinning and sizing	50–75	—	1 to 2	2.5–3.75	—
Moderate thinning and sizing	75–100	—	1 to 2	3.75–5	—
	50–75	500	1 to 2	2.5–3.75	1
Aggressive thinning and sizing	100–150	—	1 to 2	5–7.5	—
	75–100	500–1,000	1 to 2	3.75–5	1–2
Very aggressive thinning and sizing	150–200	—	1 to 2	7.5–10	—
	100–125	1,000	1 to 2	3.75–5	2

— = Information is not available.

¹ There are several factors that influence the chemical thinning outcome. Rates are generally chosen on the degree of cultivar sensitivity to chemical thinners. See *Cultivar notes*, page 70 for further information on cultivar sensitivity to chemical thinners.

² 1 ppm is equivalent to 1 mg/L.

³ Mild thinning may occur under some conditions (weak trees, young trees, sensitive cultivars, and environmental conditions that favour the thinning response).

⁴ While 6-BA has the potential to increase cell division and enhance fruit size beyond the thinning (crop load) effect alone, this is not observed in all years because the response can be affected by spray concentration, coverage, cultivar, tree health, time of application, tree stress, and environmental conditions during and following spray application.

Table 3-20. Tank Concentration of MaxCel or Cilis Plus

Spray volume required (litres/ha)	Rate of MaxCel or Cilis Plus						
	grams 6-BA/hectare						
	10	25	50	75	100	200	446
	litres of product per hectare						
	0.5	1.3	2.5	3.8	5	10.1	22.4
	concentration of 6-BA (mg/L or ppm)						
200	50	125	250	375	500	1,000	2,230
300	33 *	83	167	250	333	667	1,487
400	25 *	63	125	188	250	500	1,115
500	20 *	50	100	150	200	400	892
600	17 *	42 *	83	125	167	333	743
700	14 *	36 *	71	107	143	286	637
800	13 *	31 *	63	94	125	250	558
900	11 *	28 *	56	83	111	222	496
1,000	10 *	25 *	50	75	100	200	446
1,500	7 *	17 *	33 *	50	67	133	297
2,000	5 *	13 *	25 *	38 *	50	100	223

* (shaded area) = Concentrations of 6-BA in shaded area are not effective (for either sizing or thinning).

NAA (naphthaleneacetic acid)

Product name: FRUITONE-N

Active ingredient: NAA (naphthaleneacetic acid)

Type of thinner: A hormone-type thinner.

How it works: Absorbed primarily through the leaves from the solution. Mostly absorbed from original spray solution, not from re-wetting, and has a short life due to breakdown by sunlight. NAA affects auxin activity, and interferes with photosynthesis and proper fruit development. Affected fruitlets usually drop within 10–14 days. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

Rate: 5–20 ppm. See Table 3-17. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 65.

Timing: Apply up to 12 days after petal fall. NAA applied too soon, in the bloom to petal fall period, can result in excessive thinning of Empire.

Application: Use larger volumes of water under slow drying conditions. NAA is considered to be rainfast after 2–3 hours.

Mixing: May be mixed with carbaryl (Sevin).

Optimum conditions: Warm, dull, slow drying conditions are preferred to maximize absorption of NAA. Morning is the preferred time when trees are damp, drying is slow and temperature is on the rise. Once the material is absorbed, the tree has the day to respond to the thinner. NAA is not effective at temperatures less than 10°C.

Precautions: Do not apply during the same growing season as MaxCel or Cilis Plus, or pygmy fruit may result.

Carbaryl (Sevin)

Product name: SEVIN XLR

Active ingredient: Carbaryl

Type of thinner: An insecticide that also causes fruit thinning after petal fall.

How it works: Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application.

Rate: 0.5–2 L product per 1,000 L water. See Table 3-17. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 65. Thinning with Sevin increases as concentrations rise up to 1 kg of active carbaryl (2 L of Sevin XLR) per 1,000 L of water. There may be little or no increase in thinning with higher concentrations. 1 litre of Sevin XLR contains approximately the same amount of active ingredient (carbaryl) as 1 kg of Sevin 50 W.

Note: Sevin XLR does not provide additional thinning effects when rain or dews cause re-wetting (as was common with Sevin 50 W).

Note: Because carbaryl is relatively insoluble in water and quickly saturates the spray solution, exceeding this rate of 2 L product/1,000 L water will not increase thinning. Only the carbaryl in true solution will cause thinning.

Timing: Preferred timing is 7–12 days after petal fall (7 days when warm and 12 days when cool). Can be applied up to 21 days after petal fall if conditions are less than ideal.

Application: Apply as a separate dilute spray to thoroughly cover the trees and developing fruitlets. A 3–3.5 m tall, semi-dwarf tree on M.26 may require more than 2 L of spray to thoroughly wet the foliage.

Mixing: May be tank-mixed with NAA, MaxCel or Cilis Plus.

Optimum conditions: Best applied at temperatures between 21–24°C, under slow drying conditions.

Precautions: Sevin can be harsh on beneficial insects and mite predators. Remove bees from orchard and surrounding fields before applying Sevin as it is very toxic to bees.

Carbaryl (Sevin) + NAA

This combination has been used successfully on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains. Use a constant rate of 1 L Sevin XLR (product) per 1,000 L of water with varying rates of NAA from 3–15 ppm. Since NAA only has one chance to work, use high water volumes.

Sevin + MaxCel or Cilis Plus

Combination sprays of Sevin and 6-BA are required for difficult-to-thin cultivars or for situations where aggressive thinning is required to decrease crop load to improve final fruit size.

Calculating Parts per Million (ppm)

1 ppm = 1 g active ingredient
per 1,000 L water

Precautions

Do not apply MaxCel or Cilis Plus in combination with the hormone thinner, NAA (naphthaleneacetic acid), either as a tank-mix or separate sprays during the same growing season. Doing so may result in pygmy fruit.

Bee Warning

When Sevin is used for fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To minimize bee kills, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR is much safer to use than Sevin 50 W around honeybees. Advise local beekeepers of your spray activity.

Factors influencing response to thinning agents

Length of wetting period and temperature for material absorption

Higher temperatures allow plants to absorb thinning materials more quickly. Optimum temperatures for absorption are in the 20–25°C range. At these temperatures, drying time is usually much faster than early morning or evening when temperatures are 10–15°C cooler. Under cooler conditions, absorption is slower and stretches over a longer period or until the canopy dries.

The total amount of thinning chemical absorbed by the tree canopy appears to be more or less equal regardless of drying time (i.e., warm temperatures and fast drying, or cool temperatures and slower drying). Time of day for application of thinners is not a critical factor. Research on selected cultivars suggests minimal differences in success based on timing of sprays during day or night. However, early morning or evening sprays will reduce the likelihood of blowing thinners off-target since winds tend to be calmer.

Cultivar sensitivity (mature trees)

Easy-to-thin or easy-to-over-thin cultivars include Ambrosia, non-spur Red Delicious, Idared, Mutsu/Crispin, Jonagold strains, Jersey mac, Honeycrisp, Gingergold, Silken, Creston, Cameo and Golden Supreme.

Moderately difficult cultivars include Empire, McIntosh, Northern Spy and Cortland.

Harder-to-thin cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Goldrush, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

Weather conditions

These weather conditions encourage absorption of chemical thinners, which may increase the thinning response:

- cool, wet weather and low light conditions before or after application
- prolonged period of high humidity without rain, either before or after application
- high temperatures after cool periods

- frost or near-freezing temperatures before or shortly after application
- prolonged period of dry weather before or after application
- excessively warm conditions following fruit set

A decrease in thinning response can result from sunny and warm daytime temperatures accompanied by relatively cool night temperatures before and after thinning treatments have been applied. This results in a high net accumulation of carbohydrate reserves in the tree.

Pollination and bee activity

Pollination and bee activities are closely tied with weather conditions. Pollination conditions and bee populations can make fruit either more or less difficult to thin. Fruit set under good pollination conditions, which results in increased seed count, is harder to thin. Fruit set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered fruit. Even a light or spotty set with clustered fruit should be thinned, in order to break up the clusters.

Tree age and vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 years, so hand thinning young trees of high value cultivars is recommended. Even low rates of thinners that work on mature trees can easily over-thin young trees.
- Mature trees with winter-injured buds, or trees that are low in vigour, are more easily thinned.
- Trees bearing a heavy crop with good bloom one year may be more easily thinned the next year.
- The heavier the bloom, the more stress on the tree and the easier to thin. Producing flowers and pollen requires nitrogen and adds stress to the tree.
- Stress from the previous season makes a tree easier to thin (e.g., excessively dry, excessively wet, nutritional deficiencies, insect or disease injuries).

Density of foliage

- Poorly pruned dense trees are thinned more easily than well-pruned open trees with stronger fruit buds.
- Partially shaded spurs on low branches of well-pruned trees thin more easily than upper spurs.

- Late thinning sprays require increased water volumes for adequate coverage of the rapidly developing tree canopy.

Spray coverage

As with all plant growth regulators, complete coverage is essential for good results. Chemical thinners will act only where deposited.

Timing of application

- Application timings vary with the chemical used. See *Chemicals available for thinning*, page 66, and notes on timing for each product. Petal fall is an important stage for making thinning decisions. Petal fall is when 80% of the petals have fallen but before calyx lobes are closed.
- NAA: Apply up to 12 days after petal fall. Avoid bloom to petal fall sprays on Empire due to excessive thinning of Empire. See NAA (*naphthaleneacetic acid*), page 67.
- Sevin: Apply up to 21 days after petal fall. See *Carbaryl (Sevin)*, page 67.
- Sevin + MaxCel or Cilis Plus, and NAA + Sevin: Apply 7–12 days after petal fall (7 days if warm, 12 days if cool), except on early cultivars. See *Carbaryl (Sevin) + NAA and Sevin + MaxCel or Cilis Plus*, page 68.

For some cultivars, apply chemical thinners based on the average fruitlet diameter. See Table 3-18. *Optimum Fruitlet Size for Chemical Thinning*, page 66. Apply thinners when the king bloom fruitlets reach the stated diameter to cause the smaller and weaker fruitlets to drop off. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all fruit to be thinned is fairly uniform.

Chemical thinners are usually most effective on fruit that is 8–12 mm in diameter – but results depend significantly on weather conditions in the days following application.

For more information, see OMAF Factsheet, *Adjusting, Maintaining and Cleaning Airblast Sprayers*.

Cultivar notes

Ambrosia

This spurry upright-growing cultivar has been successfully thinned in Ontario with moderate rates of Sevin XLR. A well-thinned crop of Ambrosia produces good fruit size and colour development. The picking window for Ambrosia is narrow if the crop is to be held in long-term storage. Consult OMAF Factsheet, *Commercial Production of Ambrosia Apples in Ontario*.

Aurora Golden Gala™

Aurora Golden Gala™ can be extremely productive and therefore requires early and heavy thinning for acceptable fruit size. The cultivar appears to thin relatively well with moderate rates of carbaryl. It requires a follow-up hand thinning to space fruitlets 15–20 cm apart. Match crop load to trunk diameter. Many young Aurora trees have been cropped too heavily, resulting in small fruit, delayed maturity, poor colour, poor taste and generally poor quality fruit. This cultivar responds well to Surround Crop Protectant particle film to increase fruit size and improve shape and fruit finish.

Cameo

Trees can normally handle heavy crop loads in a vigorous canopy. This cultivar has been shown to thin adequately with Sevin XLR (1 L/1,000 L water) on established trees.

Creston

Creston has been shown to over-thin easily with low to moderate rates of Sevin XLR. It is a productive large-size cultivar that requires 2 pickings.

Empire

Before the application of NAA, make sure the king bloom fruitlet is set through a check of sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), the overall fruit size of unthinned apples may be reduced compared to treatment at a stage when the king fruitlet is 8–10 mm in diameter.

Enterprise

Enterprise appears to thin adequately with moderate rates of Sevin XLR.

Fortune

Fortune is a large-sized, highly coloured, dual-purpose apple that requires thinning to avoid biennial bearing. Fortune requires a strong treatment of NAA in combination with Sevin XLR. Experienced growers have reported success with 10 ppm NAA plus 1 L of Sevin XLR per 1,000 L of water.

Fuji

Fuji must be thinned aggressively for best results. This cultivar exhibits strong biennial characteristics and unthinned Fuji normally returns very little bloom the next year. Mature trees usually thin adequately with combinations of Sevin and NAA, but follow-up hand thinning of king fruitlets is usually necessary. Excessive crop may prevent the fruit from maturing to premium quality.

Gala

Gala is relatively difficult to thin successfully, and requires aggressive thinning on mature trees. NAA and Sevin at the rates listed for Golden Delicious have given good results, if applied when king fruitlets are 8–9 mm. Combination sprays of Maxcel or Cilis Plus and Sevin have also been very effective. Clusters must be thinned to 1 fruitlet or king bloom by mid to late June to achieve best fruit size. A follow-up hand thinning within 30 days of full bloom is normally required to further reduce crop load.

Late thinning sprays may increase the production of mummified fruitlets colonized by the fungus that causes black rot. Earlier applications produce fewer mummies, reducing black rot inoculum, and maturing fruit is less likely to be infected.

Gingergold

This cultivar appears to be more sensitive to thinners than McIntosh, Northern Spy and Empire. It can be over-thinned with high rates of NAA or strong combinations of NAA and Sevin XLR or MaxCel and Sevin XLR.

Golden Supreme

Unlike Golden Delicious, this cultivar will thin adequately with 1 L of Sevin XLR per 1,000 L water.

Goldrush

Goldrush requires a combination of NAA and Sevin XLR (10 ppm NAA + 1 L Sevin XLR per 1,000 L water). This cultivar is much tougher to thin adequately, but a well-thinned crop will mature more easily.

Honeycrisp

This cultivar seems to be more sensitive to thinning treatments than Empire. Thin Honeycrisp cautiously, as it can easily become oversized and is very prone to bitter pit. Where large fruit is a problem, it may be best to leave 2 fruitlets per cluster, or space the fruit closer together. Use of growth regulators (such as 6-BA), which enhance fruit size, may not be warranted for this large-fruited cultivar. Use no more than 2.5 ppm NAA with 1 L of Sevin XLR per 1,000 L of water as a starting point on established trees. Many growers report good fruit size distribution when the largest fruitlets are removed by hand thinning following the spray thinning treatment. Honeycrisp is highly biennial in nature and may not return an adequate crop year after year.

For a discussion on crop load and trunk circumference with respect to thinning, see OMAF Factsheet, *Commercial Production of Honeycrisp Apples in Ontario*.

Jonagold

This cultivar thins relatively easily and has good size potential when clusters are thinned to singles. Most producers get adequate thinning with moderate rates of Sevin. Over-cropping Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

Shizuka

Shizuka thins similarly to Mutsu/Crispin with moderate rates of Sevin XLR.

Silken

Silken thins with 1–1.5 L of Sevin XLR per 1,000 L of water, depending on tree age. This cultivar bruises easily. Evenly spaced fruit in the canopy is important for ease of harvest.

Suggested rates for chemical thinning of apples

The rates in Table 3-17, *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 65, are guidelines only. There is no substitute for personal experience. It is important to keep yearly records on weather conditions, rates, etc., and above all, leave some trees unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAA or Sevin, or the combination. Before you alter or modify a treatment that has proven to be effective, seek the advice of a crop consultant.

Defruiting immature apple trees

In some cases, it is desirable to defruit immature apple trees to encourage proper tree development. A dilute spray of NAA at 15 ppm combined with Sevin XLR at 1.5–2 L/1,000 L of water 5 days after petal fall, gives acceptable results. Also, successful results have been achieved with Ethrel at a concentration between 400 and 750 mg/L (ppm) when fruit are between 10 and 30 mm in diameter, typically mid-June. Well-established, supported trees under minimal stress can carry some crop load in the second year following planting.

Special conditions**Thinning after a badly frosted bloom**

Carefully evaluate damage to the bloom. Petals, stamens, pistils and ovaries can exhibit a significant difference in their response to freezing temperatures. See Figure 3-4, *Anatomy of an Apple Bloom*, page 72, for further details. Although flower petals are browned off by frost, the process of fruit set can still take place from pollination that occurred 1–2 days before the frost event.

Frost around bloom usually produces a variety of frost damage symptoms:

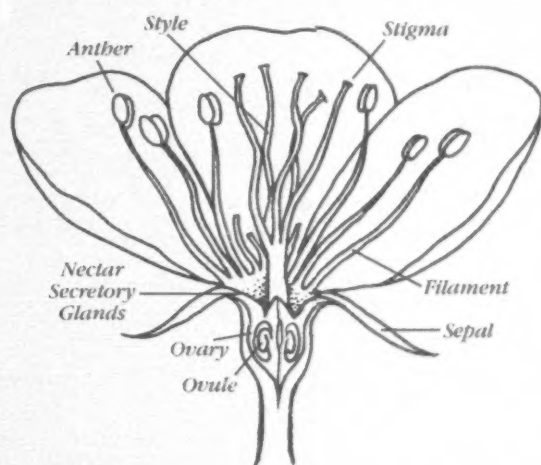
- bands of russetting around the fruitlet, called frost rings
- russetting that runs lengthways from stem to calyx
- reduced seed count and misshapen fruit (blocky or ridged)

A light amount of frost damage should not prevent the use of thinning treatments that worked in the past for any given cultivar. However, use extreme caution when thinning after a significant frost. Leaves damaged by frost absorb more of the thinner and fruitlets with reduced seed count abscise more easily. Consider the application of lower rates of thinner for many varieties under these circumstances, or on a badly damaged block, do not apply a thinner but rely on hand thinning if necessary.

Depending on the severity of the damage, growers may thin areas of the orchard that escaped the worst of the frost damage. Differences in elevation and airflow in the orchard can lead to great variations in frost damage. Trees on lower ground can be exposed to air 2–3°C colder than trees on higher ground in the same frost event.

When deciding to apply thinners, the grower may plan to spray some of the block because of what appears to be a fairly normal set on trees on higher ground. Nozzles can be shut off in areas of the block that show significant potential losses in crop load from frost. Likewise, nozzles that direct thinning sprays into the lower canopy can be shut off.

Figure 3-4. Anatomy of an Apple Bloom



Thinning when the king bloom is lost to frost

Chemical thinners usually work best when the king fruitlet is larger, stronger and more dominant than side bloom fruitlets, with the exception of Paulared. The king will normally hold on when weaker, smaller fruitlets drop in response to treatments.

If the king bloom or king fruitlet is lost to frost, size and strength differences among remaining fruitlets can be minimal, which makes them equally weak and vulnerable to thinners. The best approach in this case may be to wait until size differences appear in the cluster, provided the largest fruitlet is not greater than 12–14 mm. Size differences may become more apparent several days after full bloom. A few hours' difference in pollination timing can show up in size differences of side bloom fruitlets as the postbloom period progresses.

Thinning when weather conditions are poor

Weather conditions are often not suitable for the application of thinners even though the fruitlet diameter is at the optimum size. Sometimes cold, wet, windy or rainy weather can persist for many days. It is better to wait for warmer temperatures, more sunlight and less wind, even though fruitlet diameter is increasing. Applying thinners when king fruitlets are 12–14 mm in diameter will give a better response under warmer conditions than thinners applied to king fruitlets at

8–10 mm in persistent cold, wet and rainy conditions. Wait for warmer temperatures above 18°C during the day of application or for 24 hours after spraying.

Thinning an unevenly set crop

In most cases, apply thinners even when the crop is unevenly set. Single fruitlets are much tougher to remove from the canopy. These fruitlets can be present at the same time as multiple-set clusters in the same tree or block. In comparison, fruitlets found in clusters of 3–5 are easier to thin because of competition within the group. Ultimately, only 5–10% of the bloom in any cultivar is required to produce a commercial crop of fruit. Therefore, in situations of uneven set on unstressed trees and in the absence of frost injury, follow the recommended thinning treatments.

Key concepts and benefits of hand thinning

Hand thinning to supplement chemical thinning is becoming a standard practice in most fresh market cultivars, especially for high-valued cultivars. Hand thinning immature trees is less risky than spray thinning. Hand thin promptly after June drop.

Hand thinning will:

- help to increase fruit size and manage fruit development
- help to single the fruitlets, reducing insect feeding and improving fruit colour
- balance the number of fruiting spurs with resting spurs
- enhance return bloom if done early before fruit bud initiation
- improve pest control because spray coverage is more uniform on unclustered fruit
- improve efficiency in harvest and handling of crop
- allow the tree to continue to develop canopy
- help to prevent runted trees

Plant Growth Regulators

Promalin or Perlan to improve fruit shape of Delicious

Promalin or Perlan are plant growth regulators used on Red Delicious apples. They improve the shape of

Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. They contain a mixture of benzyladenine and two types of gibberellins. For satisfactory results, time the application carefully, follow label directions and ensure complete spray coverage.

Precautions

- If Promalin or Perlan are applied at higher rates or volumes than those recommended on the label or where blooms are weak or frost-injured, fruit thinning may occur. Promalin or Perlan use may also increase the amount of thinning achieved with subsequent blossom thinning sprays.
- Apples may not respond to Promalin or Perlan if spur vigour is low or the king blossoms have been damaged by frost.
- Do not apply Promalin or Perlan if rain is expected within 6 hours.
- Do not apply when air temperatures are lower than 24°C or greater than 32°C.

Application notes

- For optimum results, spray the first application of Promalin or Perlan between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.
- High relative humidity and slow drying conditions favour maximum absorption. It is preferable to apply in morning or evening.

Ethrel (ethephon) to enhance bloom on non-bearing trees

Apply a foliar spray of Ethrel to non-bearing apple trees, 1 to 2 weeks after bloom (determined by bearing trees in the area). On young orchard trees just beginning to initiate a few flowers, delay applications until 3 to 5 weeks after full bloom to avoid over-thinning and misshapen fruit. Vegetative growth can be reduced during the season of application, promoting flower bud development the following spring. Trees should be large enough and at a stage to bear fruit the year following application.

For spur type trees, mix 2 L Ethrel in 1,000 L of water and apply as a dilute spray to the point of runoff. For non-spur type trees, use 4.25 L of Ethrel in 1,000 L of water. For concentrate application, apply 7 L Ethrel per hectare for spur types or 14 L Ethrel for non-spur types, in 500 L of water. Note that this rate may completely

remove any fruit from trees, particularly when applied earlier than 4 weeks after full bloom.

Ethrel (ethephon) to promote fruit colouring

Ethrel can be used to improve fruit colour on apples that will be marketed immediately. Apple treated with Ethrel will not store for long. Ethrel has the following effects on trees and fruit, depending upon the timing and rate of application:

- Ethrel stimulates ripening, colour development and fruit drop. To prevent excessive premature drop after the use of Ethrel, apply a suitable stop-drop product such as naphthaleneacetic acid (NAA). Two applications are required: one as a tank-mix at the time Ethrel is applied and the second 5 days later. Apply the stop-drop at the normal rate recommended on the label.
- Spray just the number of trees that can be harvested over a 2–3-day period. Depending on cultivar and air temperature, fruit will be ready to harvest 5–10 days after the spray is applied. After a spray, check the maturity of the apples on a daily basis for pressure, starch, flavour and colour. A few trees sprayed at 3–4-day intervals are easier to manage than a large number sprayed at one time. Make sure a market is available for the treated apples before you spray, especially with early cultivars.
- Rates of application depend on cultivar, date of application, tree vigour, temperature, weather conditions and degree of response required. Early cultivars like Jerseymac and Paulared, which ripen under warmer conditions, require less material than later cultivars. On early cultivars, use 0.75–1.5 L of Ethrel per ha with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. Use the higher rate early in the season on trees high in nitrogen or on poorly pruned trees. Use lower rates on young, well-pruned trees or on trees low in nitrogen. Best results are obtained when Ethrel is applied 2–3 weeks before harvesting. Be sure to apply Ethrel uniformly, since it works only where the spray touches.

Chemical control of preharvest drop of apples

Cultivars differ in their tendency to drop apples before harvest. McIntosh and Honeycrisp are the cultivars of greatest concern in Ontario.

Conditions associated with premature fruit drop include:

- trees with high nitrogen content in late summer
- trees that carry a heavy crop
- hot days and warm nights just before and during harvest
- trees deficient in either moisture or the nutrients boron or magnesium
- trees heavily damaged by pests
- trees with fruit growing in clusters that will push off large fruit

Products to control preharvest drop

NAA

Products such as Fruitone-N and Fruit Fix Concentrate contain NAA (naphthaleneacetic acid) and are registered to control drop on apples. These contain the same active ingredient, NAA, used at different concentrations than for thinning.

- Apply NAA as soon as the first undamaged apples begin to drop, at the rate of 10 ppm or single strength rate. Timing is important. Do not confuse the normal preharvest drop of sound apples with those that have been pushed off or are dropping because of insects, disease or nutritional deficiency.
- NAA is effective for 7–10 days after it is sprayed. For stop-drop prevention beyond this, repeat the application of a single strength rate every 7 days. It takes 1–2 days for NAA to take effect if applied before any harvest has taken place. If applied after the orchard has been spot picked, it may take longer to take effect. Therefore, apply NAA as soon as the spot pick is finished. Do not apply NAA closer than 5 days before harvest. Refer to the label.
- Apply NAA in a dilute spray to achieve more uniform coverage. This is important because NAA is only locally systemic. High volumes of water take longer to dry and allow increased absorption of NAA. The optimum conditions for maximum absorption are at or near 21–24°C and high humidity. Absorption is less on foliage injured by insects, diseases or frost and at temperatures below 16°C.
- The addition of a non-ionic type spreader sticker like Agral 90 improves absorption of NAA under less than ideal weather conditions.
- NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the

concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening.

- Apples treated with NAA for preharvest drop will not keep well in long-term storage, especially McIntosh. Apples treated twice with NAA should be sold immediately.

ReTain

ReTain is a plant growth regulator and an effective preharvest drop control agent for apples such as Gala, Honeycrisp, McIntosh, Red Delicious and Northern Spy. It reduces the production of ethylene in maturing apples. Apples treated with ReTain also develop less stem-end cracking and skin greasiness.

- Apply this material 4 weeks before anticipated harvest date. ReTain may delay maturity of apples on the tree and allow a longer harvest window for a particular variety. Although ripening in ReTain-treated fruit is temporarily delayed, ReTain-treated fruit harvested at proper maturity may have increased soluble solids, colour, fruit size and firmness, and reduced water core.
- To facilitate harvest on larger acreages, consider leaving some blocks untreated for regular harvest timing, and using ReTain to delay maturity on later blocks.
- Pick fruit treated with ReTain at the same internal maturity, based on starch-iodine tests, as untreated fruit. There may be a 7–10-day delay from predicted harvest date of untreated fruit to the start of the harvest of ReTain-treated fruit.

Recommended use 4 weeks before anticipated harvest

- Use one 333 g pouch (50 g active ingredient) of ReTain per 0.4 ha (1 acre). Use with Sylgard 309 (organosilicone surfactant) at 0.5–1 L of Sylgard 309 per 1,000 L of water.
- Apply 4 weeks before anticipated harvest, adjusted for seasonal differences that have advanced or delayed "normal" harvest date. It is better to be a week early than a week late. Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the start of the "normal" harvest period, refer to historical trends for harvest dates for each cultivar in your area.

Precautions

- When you mix ReTain with the surfactant, keep agitation to a minimum because Sylgard 309 has a tendency to foam.
- To minimize foam, add Sylgard 309 last, when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available.
- Do not use surfactants other than Sylgard 309 because they are not registered with ReTain in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05–0.1% v/v ratio.
- Discard any unused spray material at the end of each day.
- Do not tank-mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (naphthaleneacetic acid) or ethephon products have not been thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.
- Do not use overhead irrigation for 8 hours after application.
- Adjust spray water volumes based on tree size and spacing. Do not apply to the point of runoff but wet the tree under slow drying conditions. Use tree-row volume (TRV) reductions cautiously and test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards, 1,000 L water per ha is adequate for size-controlling rootstocks.
- For best results, have spray water at a pH between 6 and 8.

To maximize the benefits of using ReTain, segregate treated fruit from untreated fruit in storage to reduce exposure to ethylene.

Additional considerations when using ReTain

- Spray only trees that are healthy and not under severe drought, insect, disease or nutritional stress.
- Apply treatments to Gala strains, Golden Delicious types and Honeycrisp with caution. These cultivars appear to be more responsive to ReTain compared to McIntosh. Using ReTain on these sensitive cultivars can significantly impede crop maturity and development.

- For multiple-pick cultivars such as Gala, time application 4 weeks from the second harvest pick date for best results.
- The harvest window for treated cultivars is shorter but delayed and results in fewer pickings. This can increase harvest efficiency.
- ReTain is not likely to compensate for the effects of an aggressive calcium spray program to control bitter pit. Calcium sprays can advance apple maturity by accelerating ethylene production in maturing fruit.

Vegetative growth control in apples

Apogee or prohexadione-calcium is a plant growth regulator that reduces terminal shoot growth. Apogee inhibits the synthesis of gibberellins, the plant hormones responsible for cell elongation. Trees treated with Apogee often have the same number of shoots as untreated trees, but shoots from treated trees are thicker or greater in diameter and have compressed internodes. Apogee does not reduce the number of leaves or fruit size. When used properly in apple orchards, Apogee can:

- reduce shoot growth by 20–60% and diminish the time required to dormant prune and/or summer prune
- lead to improved fruit colour on red-coloured cultivars
- result in a more open tree canopy, which will improve spray coverage
- reduce the incidence and severity of fire blight on shoots, but not blossom blight infections

Apogee can play an important role in suppressing fire blight in new high-density orchards, because it reduces vegetative growth, making the trees less susceptible to shoot infection. However, Apogee has no activity against the fire blight bacteria or blossom blight. For more information on timing and rate, see *Late bloom/Early petal fall* section in the Apple Calendar, page 39.

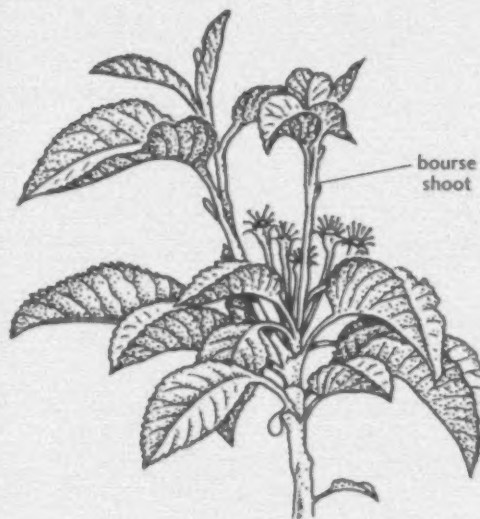
Time of application and rates

Patterns of terminal growth and fruit set differ among growing regions. Likewise, the response to Apogee appears to differ between regions. Therefore, the rate and calendar date of application may vary between regions.

Make the first application when terminal shoots (and/or bourse shoots) are no longer than 2.5–5 cm. Some cultivars show early bourse shoot development see Figure 3-5. *Bourse Shoot Development*, page 76. *Note:* This first application timing often occurs during bloom

or petal fall, so check closely for new shoots when king bloom petals start to fall. Sufficient leaf area must be available for Apogee to be translocated into the leaf. Later timings will not provide satisfactory results. See Table 3-21-A. *Suggested Apogee Timings*, page 77.

Figure 3-5. Bourse Shoot Development



Apogee is non-toxic to bees, so the first application can be made before bees are removed from the orchard.

Once applied, Apogee requires about 14 days to slow growth. It breaks down in the trees within a few weeks, so at least 1 additional application may be necessary to maintain growth control throughout the entire growing season.

See Table 3-21-B. *Suggested Apogee Rates (g Apogee per ha)*, page 77, for rates. The application rate is determined primarily by tree size, vigour, and whether protection against shoot blight is an objective.

- for medium to high vigour trees, apply 45 g product per 100 L of dilute spray (125 ppm)
- for low to medium vigour trees, apply 27 g product per 100 L of dilute spray (75 ppm)

Repeat application(s) should be made at 14–21-day intervals, based on the level of growth control required.

Follow the steps on the label to adjust rates for tree-row volume dilute applications. Table 3-21-B. *Suggested Apogee Rates (g Apogee per ha)*, page 77, shows various rates for sprays applied at 1,000 L/ha (dilute). Apogee has been used effectively when applied in more concentrated sprays, provided thorough wetting

of the canopy is achieved. Low-volume spraying of plant growth regulators and chemical thinners is not recommended.

Do not tank-mix Apogee with calcium sprays like calcium chloride. In the presence of calcium, Apogee will precipitate in the tank, clog nozzles and screens, and reduce tree response.

Adjuvants and hard water

Include the spray adjuvant, Agral 90, with Apogee to improve the uptake of the prohexadione-calcium molecule by the leaf. In addition, if the spray water source is hard water and contains high levels of calcium or magnesium, include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee. Use a high-quality, greenhouse grade of AMS to avoid plugging of nozzles. Obtain water hardness ratings from your municipal water supplier, or have well water tested for hardness. Consult www.ene.gov.on.ca/en/water/duval/licensedlabs.php for a list of accredited labs that conduct these tests.

Precautions when using Apogee

In some instances, Apogee may increase fruit set and make thinning more difficult. This response is not consistent but is more likely at concentrations above 125 ppm (45 g/100 L). Apogee-treated trees may require more aggressive chemical or hand thinning to reduce the crop load to the desired level.

Apogee can cause severe cracking on Empire and Stayman cultivars as stated on the product label. The cause is unclear, but may be related to environmental conditions. Reports of cracking damage of Empire when Apogee has been used are increasing. Compliance with the label is strongly advised. Apogee may result in decreased yield and marketable yield of Cortland. Despite this, clear benefits of the use of Apogee on tip-bearing cultivars such as Cortland and Northern Spy have been observed in other regions of Canada where the shortened internodes of Apogee-treated trees have produced a more compact tree habit.

Table 3-21-A. Suggested Apogee Timings

	1st Spray	2nd Spray	3rd Spray	4th Spray
Stage →	Petal fall	Fruit set	June drop	Growth
Typical date¹, SW Ontario →	25-May	8-Jun	22-Jun	6-Jul

¹ Make the first application when terminal shoots are no longer than 2.5–5 cm, which usually corresponds with late bloom to petal fall. This will vary with tree growth and development in your area and by cultivar. These are approximate dates in southwestern Ontario. Growers with orchards in other areas should note the appropriate tree phenology stage to time these applications correctly.

Table 3-21-B. Suggested Apogee Rates (g Apogee per ha)

Based on a Tree-Row Volume Dilute of 1,000 L/ha³ (use this chart in conjunction with the product label)

Apogee Program Level	Tree Vigour ²	# Sprays	1st Spray Petal fall	2nd Spray Fruit set	3rd Spray June drop	4th Spray Growth	Season Total ⁴ (g/ha)
1	Low	1 spray	450	—	—	—	450
2	Low	2 sprays	270	270	—	—	540
3 ¹	Medium	2 sprays	450	450	—	—	900
4	Medium/High	3 sprays	450	450	270	—	1170
5	High	3 sprays	450	450	450	—	1350
6	High	4 sprays	450	450	450	270	1620

— = No activity or activity unknown.

¹ Suggested base rate. Move to next higher or lower level based on factors listed in Table 3-21-C. Orchard and Environmental Factors used to Adjust Apogee Rates and Number of Sprays.

² Vigour is defined as the total amount of shoot growth in a single season, not to be confused with tree-row volume.

³ Tree-row volume (see OMAF Factsheet, *Adjusting, Maintaining, and Calibrating Airblast Sprayers* for more details). Rates need to be increased when higher water volumes are required for adequate spray coverage.

⁴ Maximum seasonal rate should not exceed a total of 5.4 kg of Apogee.

Table 3-21-C. Orchard and Environmental Factors to Adjust Apogee Rates and Number of Sprays

Factor	How to adjust Apogee rates if factor occurs
Heavy dormant pruning	increase rate by 10–20 % per ha per spray
Longer growing season	add 3rd or 4th spray
Low crop load	move Apogee Program to next higher level
Questionable coverage	move Apogee Program to next higher level
Fire blight suppression	move Apogee Program to next higher level or apply (650 g/1,000 L) initial rate

THINNING AND PLANT GROWTH REGULATORS

4. Berry Crops

Berry Crop Nutrition

Blueberries, Highbush

Blueberries perform best on acidic, well-drained soils with high organic matter content.

- Before you plant, test the soil to determine the pH and fertilizer requirements.
- Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will draw soil moisture away from plant roots, so be sure it is thoroughly moistened before planting.

pH requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically through the use of sulphur or peat moss. For this reason, choose the site for blueberry production carefully.

- If the soil pH is too high but less than 6.5, acidify through the incorporation of elemental sulphur and/or acidic peat moss prior to planting. See Table 4-1. *Sulphur Requirements to Lower Soil pH* on this page.
- Incorporate sulphur at least 1 year prior to planting to allow sufficient time for the sulphur to acidify the soil.
- Check the soil pH annually in the plant row and add sulphur when necessary.

Fertilizer for blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate nitrogen fertilizers. In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Apply the nitrogen just prior to bud break, petal fall and early July. Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. Increase the rate of nitrogen each year until a total of 36–48 g per bush is applied. On older bushes,

apply most of the fertilizer under the outer spread of the branches. See Table 4-2. *Nitrogen Requirements for Highbush Blueberries* on this page. Avoid fertilizers containing lime filler as they will raise the pH of the soil.

Table 4-1. Sulphur Requirements to Lower Soil pH

Soil type	Sulphur required to lower soil pH	
	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110

Example: The initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8. The soil pH must be lowered by $6.2 - 4.8 = 1.4$ units. Therefore, $1.4 \times 750 = 1,050$ kg/ha of sulphur is required.

Table 4-2. Nitrogen Requirements for Highbush Blueberries

Plant age	Nitrogen required (g per plant)		
	April 1–15	May 15	July 1
Newly planted	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 4-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 80, for soil test interpretation. A single application of phosphorus at soil preparation time is usually adequate. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in the spring under the outer branches of the bushes, as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (0-0-22, 11% magnesium) or potassium sulphate (0-0-50, 17% S). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Table 4-3. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries

Phosphorus				Potassium		
Soil test (ppm P)*	Rating	Phosphate required (kg P ₂ O ₅ per ha)		Soil test (ppm K)**	Rating	Potash required (kg K ₂ O per ha)
		New plantings	Established plantings			
0–3	HR	140	100	0–15	HR	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15		90	60	81–100		80
16–20	MR	70	50	101–120	MR	70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	LR	0	0	above 180	LR	0

HR, MR, LR, denote, respectively: high, medium, and low probabilities of profitable crop response to applied nutrient.

* 0.5 M sodium bicarbonate extract soil test method.

** 1.0 N ammonium acetate soil test method.

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg/ha is required where a confirmed deficiency exists. Use magnesium sulphate (Epsom salts, 95% Mg) or sulphate of potash magnesia (0-0-22, 11% Mg). Since sulphate of potash magnesia contains potash, adjust application rates to meet potash requirements. For foliar sprays, 1.9 kg Mg/1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Table 4-4. Optimum Nutrient Levels in Highbush Blueberry Leaves

Nutrient	Optimum range
nitrogen (N)	1.7–2.3%
phosphorus (P)	0.15–0.4%
potassium (K)	0.36–0.7%
calcium (Ca)	0.3–0.8%
magnesium (Mg)	0.12–0.3%
manganese (Mn)	150–500 ppm
iron (Fe)	30–100 ppm
zinc (Zn)	10–100 ppm
boron (B)	15–50 ppm

See Appendix F: Accredited Soil-Testing Laboratories in Ontario, page 298, for a list of laboratories that provide leaf analysis.

Leaf analysis

Leaf analysis can help to assess the nutrient status of the plants and more accurately determine fertilizer requirements. In late July, take leaf samples from halfway down the new shoot growth of the current season. Ensure adequate representation by collecting at least 100 leaves throughout the sampling area. Sample areas with different soil types, crop age, and current fertility programs separately. See Table 4-4. *Optimum Nutrient Levels in Highbush Blueberry Leaves*, on this page.

Currants and Gooseberries

It is essential to apply and incorporate required materials such as phosphorus, potassium, organic matter and lime before you plant currants and gooseberries because these materials do not move easily through the soil.

Complete a soil test at least a year before planting. Prepare the soil and adjust pH if required as determined by the soil test. This will ensure the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil organic matter should be at least 2–3% to promote good drainage, aeration and moisture retention.

Apply 45 tonnes/ha or 4.5 kg/m² of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well-decomposed by planting time. For more information on organic matter, see Soil Management at www.ontario.ca/crops.

pH requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming may be required to raise soil pH to 6.1.

If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil pH and Liming*, page 12. Micronutrients may become limiting if soil pH is outside the recommended range.

Fertilizer before planting

Incorporate phosphorus and potassium fertilizer into the soil in early spring a few days before planting. Incorporate nitrogen before planting or apply in a band around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen. If planting takes place in the fall, incorporate required phosphorus before planting but delay application of nitrogen and potassium until the following spring.

Nitrogen (N)

Incorporate or band 5 g of actual nitrogen per bush in the planting year.

Phosphorus (P)

Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. See Table 4-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 80, for more information. Recommended phosphorus rates to meet plant requirements must be incorporated prior to planting. Phosphorus does not move easily through the soil to the roots. It is difficult to effectively incorporate phosphorus after the crop is planted. Excessive levels of phosphorus can induce deficiencies of other essential nutrients such as zinc.

Potassium (K)

Test the soil before planting and apply the required amount of potassium according to the soil test results. See Table 4-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 80. Currants and gooseberries are

sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use potassium sulphate (0-0-50) or sulphate of potash magnesia (0-0-22) instead.

Fertilizer in established plantings

Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, reduce rates to the percentage of area that will receive fertilizer. If the fertilizer is banded, band 30 cm from the base of the plant.

Nitrogen (N)

Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g per bush.

Potassium (K)

Apply according to soil test results. If a soil test is not available, assume a moderate level and apply as indicated in Table 4-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 80.

Raspberries

Raspberries have a fine, fibrous root system and perform best on a deep, well-drained soil. Raspberry soils need good water retention ability and a high organic matter content of approximately 3%. For more information on organic matter, see Soil Management at www.ontario.ca/crops.

One year before planting raspberries, test the field soil for phosphorus, potassium, magnesium and pH. Adjust soil pH and organic matter if necessary. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting.

pH requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 12 months before planting. For more information on lime, consult *Soil pH and Liming*, page 12. Micronutrients may become limiting when soil pH falls outside the appropriate range.

Fertilizer for raspberries

Nitrogen (N)

Suggested nitrogen application rates are found in Table 4-5. *Nitrogen Rates for Raspberries* on this page. Avoid the application of excessive nitrogen. It can reduce the number of berries per cane and cause excessive vegetative growth. Sources of nitrogen and nitrogen equivalents are presented in Table 2-9. *Fertilizer Materials: Primary Nutrients*, page 15.

For summer- and fall-bearing raspberries, apply nitrogen in early spring (late March to early April). Late applications may lead to winter injury. For fall-bearing raspberries, winter injury is not a concern because canes are removed each spring. However, ripening may be delayed where nitrogen is applied in excess.

Table 4-5. Nitrogen Rates for Raspberries

Year	Nitrogen (kg/ha per season)
Planting year	30–40
Second year	40–60
Third and following years	45–75

Use the lower rates on non-irrigated crops and heavier soils.
Apply higher rates to irrigated crops and sandier soils.

Phosphorus (P) and Potassium (K)

Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test.

Incorporate phosphorus prior to planting to correct phosphorus deficiencies, as phosphorus does not move readily through the soil. Do not apply more phosphorus than is required; excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

If the soil test recommends high rates of potash, use potassium sulphate (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 2-9. *Fertilizer Materials: Primary Nutrients*, page 15.

Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Sample the soil every 2–3 years.

Leaf analysis

Collect fully expanded mature raspberry leaves from fruiting canes in late July. See Table 4-6. *Optimum*

Nutrient Levels in Raspberry Leaves on this page. These ranges provide a guide for interpretation of results. Variation can occur because of cultivars, soil type and cultural practices.

Table 4-6. Optimum Nutrient Levels in Raspberry Leaves¹

Nutrient	Optimum range
nitrogen (N)	2–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1–2%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm

¹ See Appendix F: *Accredited Soil-Testing Laboratories in Ontario*, page 298, for a list of laboratories that provide leaf analysis.

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries develop. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Provide an optimum environment for strawberry root growth to obtain a profitable, perennial planting.

One year before planting strawberries, adjust soil pH and organic matter. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting. Test the field soil for phosphorus, potassium, magnesium and pH.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH; however, some micronutrients become less available outside this range, particularly when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil pH and Liming*, page 12.

Fertilizer for new plantings (the planting year)

Nitrogen (N)

Nitrogen can be applied with the phosphorus and potassium or as a side dressing 2–3 weeks after planting. Apply 50 kg of N per ha. See Table 2-9. *Fertilizer Materials: Primary Nutrients*, page 15, for nitrogen content of fertilizers. Apply an additional 25–35 kg N per ha in mid-August to further invigorate plants as they initiate fruit buds for the next year's crop.

Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply when leaves are wet. The nitrogen in urea (46-0-0) can be lost as ammonia gas if it is applied to the soil surface and not incorporated. This ammonia can cause strawberry leaves to blacken. Incorporating urea prevents this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease.

Adjust nitrogen rates proportionately if manure was applied. See Table 2-10. *Average Fertilizer Replacement Values For Manure*, page 16. For more information about food safety and the environmental effect of manure application, please see *Use manure responsibly* and *Manure and food safety*, page 16.

Phosphorus (P)

Use soil test results to determine the best rate of phosphorus to apply. Table 4-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 80, shows soil test values and fertilizer requirements for new strawberry plantings. Incorporate phosphorus into the soil before you plant. Soils differ in the amount of phosphorus available to plants. Generally, fields cultivated for a long time require less phosphorus than recently developed fields.

Starter solutions

To help the plant establish, particularly if the soil is cold, use a starter fertilizer solution. Plant uptake of soil phosphorus can be reduced when soils are cold. Use a starter solution high in phosphorus such as 10-52-10, 6-24-6 or 10-24-0. Follow the manufacturer's suggested application rate.

Potassium (K)

Use soil test results to determine the best rate of potassium to apply. Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Fertilizer for established plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour, which results in softer fruit and dense canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by 1 or 2 days.

Benefits have been reported from low nitrogen application rates (10–20 kg N per ha) in the spring after mulch removal to plants growing in coarse-textured soils. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After you mow the foliage, apply 50 kg N per ha using whatever form of nitrogen is most economical. See Table 4-7. *Nitrogen Rates for Strawberries*, page 84. Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. The nitrogen in urea (46-0-0) can be lost as ammonia gas if it is applied to the soil surface and not incorporated. This ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem. Apply an additional 25–35 kg N per ha in mid-August to assist the development of next year's fruit buds.

Ensure soils are well-irrigated after renovation, throughout the summer and in early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

If a soil test shows phosphorus is needed, apply at renovation with nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils.

Potassium (K)

Apply potassium, as determined by a soil test, with nitrogen and phosphorus at renovation. This allows for incorporation. Use soil tests to determine what rate

to apply and use leaf analysis to adjust rates. Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

Table 4-7. Nitrogen Rates for Strawberries

Plant age	Nitrogen (kg/ha)		
	Before planting or 2–3 weeks after planting	Renovation (after harvest)	Mid-August
Planting years	50	NA	25–30
Established plantings	NA	50	25–30

Leaf analysis

Leaf analysis can help assess the nutrient status of strawberry plants and more accurately determine fertilizer requirements. Take leaf samples by July 1 for fruiting or August 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves with petioles removed. Different varieties, soil types and plantings should be sampled separately. See Table 4-8. *Optimum Nutrient Levels in Strawberry Leaves*, on this page, for interpretation of leaf analysis values.

Table 4-8. Optimum Nutrient Levels in Strawberry Leaves¹

Nutrient	Optimum range
nitrogen (N)	2–3%
phosphorus (P)	0.2–0.5%
potassium (K)	1.5–2.5%
calcium (Ca)	0.5–1.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
boron (B)	20–60 ppm

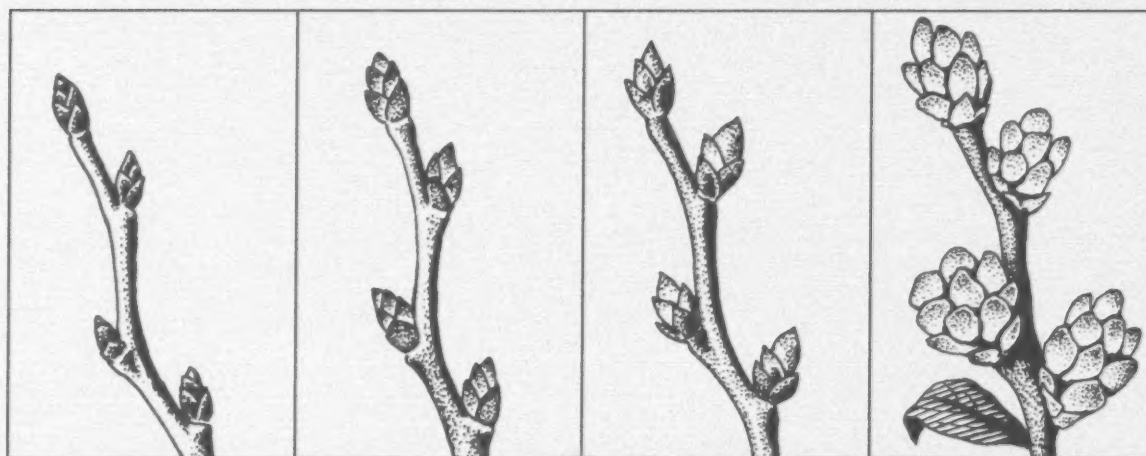
* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before August 20 in non-fruiting fields.

¹ See Appendix F: *Accredited Soil-Testing Laboratories in Ontario*, page 298, for laboratories that provide leaf analysis.

Micronutrients for Berry Crops

Deficiencies of micronutrients are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem. Leaf analysis is more effective than soil analysis to evaluate a crop's micronutrient status. See *Micronutrients*, page 21, for additional information.

Figure 4-1. Blueberry Growth Stages



Dormant

Bud Swell

Green Tip

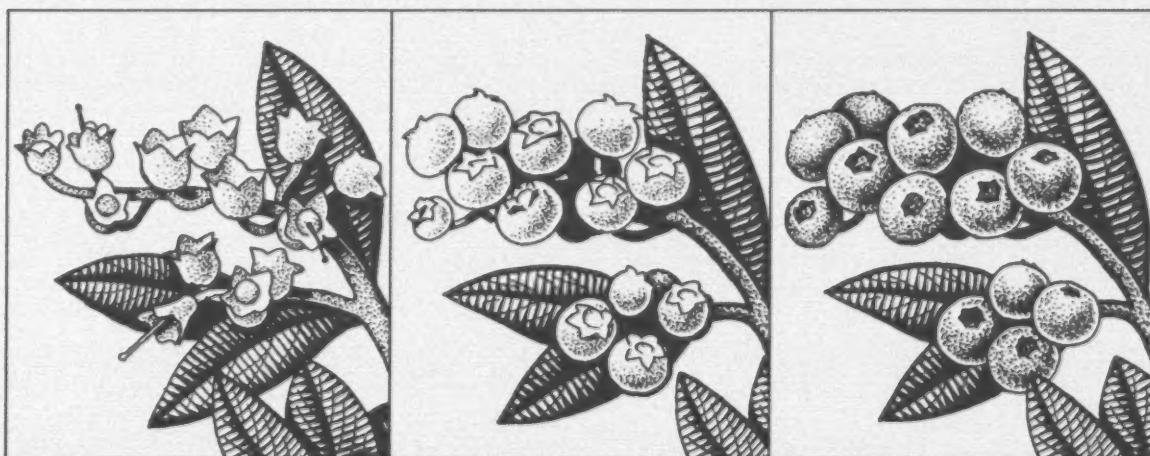
Bud Cluster



Pink Bud

Bloom

Petal Fall



Calyx

Green Fruit

Fruit Ripening

Blueberry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. For mature highbush blueberries, use 700–1,000 L of water per ha unless otherwise noted on the label.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-9, *Products Used on Blueberries*, page 92.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to blueberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (late winter)			
Scale insects	• Lime Sulphur (M)	36.7 L Lime Sulphur plus	Apply when plants are dormant. Spray to the point of runoff. Ensure thorough coverage. Use 1,000–1,500 L of water per ha. Do not use within 10 days of Bravo, Echo, Supra Captan, Maestro or within 48 hours of freezing temperatures. Purespray Green Spray Oil, Superior 70 Oil: Labelled for Lecanium scale only.
Lecanium scale	plus dormant oil	12.5 L Oil/1,000 L water	
	• Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water	
	Superior 70 Oil (NC)	20 L/1,000 L water	
Early spring, prior to bud break			
Phytophthora root rot	• Ridomil Gold 480 SL (4)	Banded: 37 mL/100 m of row	Apply to the soil surface in a 1-m band centered over the row. Use at least 2,000 L of water per ha. Alternatively, use Aliette at Bud swell to pink bud . Improve soil water drainage and adjust irrigation schedules to reduce problems with this disease.
Bud swell to green tip			
Leaf tiers	• Decis 5 EC (3)	150 mL/ha	Damage from this occasional pest occurs very early in the season. If leaf tier was a problem in the past, spray at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
Obliquebanded leafroller (OBLR)	• Delegate WG (5)	200 g/ha	Where OBLR has been a problem in the past, spray if overwintering OBLR larvae are easy to find. Otherwise, use pheromone traps to monitor for adults and spray for the summer generation at Green fruit . Many of these products are also labelled for spanworms (known as inchworms or loopers) and other caterpillars. See product label for a complete list of registered uses. Exirel: Do not tank-mix or make sequential applications with Cabrio, Pristine, Maestro or Supra Captan.
	• Success (5)	145–182 mL/ha	
	or Entrust 80 W (5)	80–109 g/ha	
	• Intrepid 240 F (18)	0.5 L/ha	
	• Altacor (28)	285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
Mummy berry (<i>Monilinia</i>)	• Funginex DC (3) • Topas (3) - or Jade (3) - or Mission 418 EC (3) • Quash (3) • Proline 480 SC (3) • Allegro 500 F (29) • Serenade MAX (44)	1.7–3 L/ha 500 mL/ha 500 mL/ha 300 mL/ha 180 g/ha 315–420 mL/ha 2.24 L/ha 3.5–6.0 kg/ha	Cultivate before bud break to bury overwintering inoculum. Monitor for trumpet-shaped structures erupting from mummified berries on the ground. Spray to prevent primary infection of blueberry shoots. Make the first application when the flower buds swell and repeat until first bloom. Funginex: Do not spray after pink bud stage. Allegro, Serenade MAX, Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Serenade MAX: See <i>Using Organic and Biopesticide Products</i> , page 242. For best results, use multiple applications or rotate with other products.
Phytophthora root rot	• Aliette (33)	5.6 kg/ha	Apply in spring when there is 7 cm of new growth and repeat in 14–21 days. Improve soil water drainage and adjust irrigation schedules to reduce problems with this disease.
Green tip			
Anthracnose fruit rot Phomopsis	• Bravo 500 (M) - or Echo 720 (M) • Quash (3) • Pristine WG (7+11) • Cabrio EG (11) • Allegro 500 F (29) • Aliette (33) - or Confine Extra (33)	7.2 L/ha 5 L/ha 180 g/ha 1.3–1.6 kg/ha 1 kg/ha 2.24 L/ha 5.6 kg/ha 4–5 L/ha	Apply fungicides to prevent twig blights and reduce overwintering inoculum. Bravo, Echo: Will also control alternaria fruit rot. Quash: Provides control of anthracnose and suppression of phomopsis. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Pristine: Use 1.6 kg/ha for phomopsis stem canker. Allegro: Suppression only. Aliette: Provides control of anthracnose and suppression of phomopsis. Apply at 14–21-day intervals. Confine Extra: Suppression of anthracnose. Not registered for phomopsis. Apply at 14–21-day intervals.
Pink bud			
Anthracnose fruit rot Phomopsis	Use one of the products listed for anthracnose fruit rot and phomopsis at Green tip .		
DO NOT APPLY INSECTICIDES WHILE BLUEBERRIES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
First bloom			
Anthracnose fruit rot Phomopsis	• Quash (3) • Pristine WG (7+11) • Cabrio EG (11) • Switch 62.5 WG (9+12) • Allegro 500 F (29) • Aliette (33) - or Confine Extra (33)	180 g/ha 1.3–1.6 kg/ha 1 kg/ha 775–975 g/ha 2.24 L/ha 5.6 kg/ha 4–5 L/ha	Quash: Provides control of anthracnose and suppression of phomopsis. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Pristine: Use 1.6 kg/ha for phomopsis stem canker. Switch: Use for anthracnose fruit rot. Not labelled for phomopsis. Allegro: Suppression only. Aliette: Provides control of anthracnose and suppression of phomopsis. Apply at 14–21-day intervals. Confine Extra: Suppression of anthracnose. Not registered for phomopsis. Apply at 14–21-day intervals.
Botrytis twig and blossom blight Botrytis fruit rot (grey mould)	• Supra Captan 80 WDG (M) - or Maestro 80 DF (M) • Ferbam 76 WDG (M) • Cantus WDG (7) • Pristine WG (7+11) • Scala SC (9) • Switch 62.5 WG (9+12) • Elevate 50 WDG (17) • Serenade MAX (44)	2.25 kg/ha 2.25 kg/ha 3.75 kg/1,000 L water 560 g/ha 1.3–1.6 kg/ha 2 L/ha 775–975 g/ha 1.7 kg/ha 3–6 kg/ha	Apply fungicides for botrytis blights when wet weather occurs. Repeat at 7–10-day intervals through bloom if wet weather continues. Ferbam: Do not use later than mid-bloom. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. For best results, use multiple applications or rotate with other products. See <i>Using Organic and Biopesticide Products</i> , page 242.

Disease or Insect	Product (Group)	Rate	Comments
Petal fall			
Cherry fruitworm	• Sevin XLR (1)	4 L/ha	Moths lay eggs on developing fruit and larvae tunnel into fruit. Use pheromone traps to monitor moth activity and to time the spray accurately. If traps are not used, spray at petal fall and again in 7–14 days. Apply in sufficient water to ensure good coverage. If bloom or bee hives are still present, choose a product with low bee toxicity, such as Dipel, Bioprotect, Altacor or Intrepid for the petal fall spray. Refer to label for bee toxicity statements. Sevin: Apply at peak trap capture. Re-apply 7 days later if trap catches remain elevated. For cranberry fruitworm only. Malathion: Apply at peak trap capture. Repeat twice at 4–5-day intervals. A fourth spray is required if trap catches remain elevated. If cranberry fruitworm is not a problem, use 550 mL/ha for cherry fruitworm. Assail: Has activity on eggs and larvae. Apply when trap captures are increasing or at peak trap capture. Re-apply in 10–14 days if trap catches rise again. Dipel, Bioprotect: Have activity on young larvae as they emerge from eggs and feed on treated tissue. Spray at first upswing in trap captures and continue at 3–7-day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See <i>Using Organic and Biopesticide Products</i>, page 242. Rimon: Has activity on eggs and young larvae. Spray at first upswing in trap captures and re-apply in 10–14 days. Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area. Intrepid: Has activity on eggs and young larvae. Spray at first upswing in trap captures and re-apply in 10–14 days. For cranberry fruitworm only. Altacor, Exirel: Apply insecticide at first sustained upswing in trap catch. Re-apply in 7–10 days. Do not tank-mix or make sequential applications of Exirel with Cabrio, Pristine, Maestro or Supra Captan.
Cranberry fruitworm	• Malathion 85 E (1)	1 L/ha	
	• Assail 70 WP (4)	160 g/ha	
	• Dipel 2X DF (11)	1.68 kg/ha	
	or Bioprotec CAF (11)	1.4–2.8 L/ha	
	• Rimon 10 EC (15)	1.35–2.0 L/ha	
	• Intrepid 240 F (18)	0.5 L/ha	
	• Altacor (28)	215–285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	
White-marked tussock moth	• Bioprotec CAF (11)	4 L/ha	White-marked tussock moth is a sporadic pest. Larvae devour foliage. Make 2 applications 2–5 days apart, when larvae are very small, usually just after bloom. A second generation may require control in late summer.
	• Foray 48BA (11)	4 L/ha	
European chafer larvae	• Admire 240 F (4)	1.2 L/ha	Admire, Alias: Toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements. Do not apply during bloom or when bee hives are present. Apply just prior to egg hatch (shortly after adults are active) to damp soil around bushes and to grass-covered areas around blueberry field. Apply in 200 L water per ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application but avoid overwatering. Maximum of 1 application per season, at petal fall, green fruit or after harvest. These products will reduce numbers of white grub larvae but may not provide control. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Japanese beetle larvae	or Alias 240 SC (4)	1.2 L/ha	
Anthracnose fruit rot	• Bravo 500 (M)	7.2 L/ha	Most fruit infections occur in the bloom to green fruit stage. Infected fruit soften near harvest time and orange spore masses develop on the fruit. Bravo, Echo: Also control alternaria fruit rot. May cause fruit injury if applied to green fruit. Allegro, Confine Extra: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Confine Extra, Allette: Apply at 14–21-day intervals.
	or Echo 720 (M)	5 L/ha	
	• Cabrio EG (11)	1.0 kg/ha	
	• Pristine WG (7+11)	1.3–1.6 kg/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
	• Allegro 500 F (29)	2.24 L/ha	
	• Allette (33)	5.6 kg/ha	
	or Confine Extra (33)	4–5 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
Phomopsis	- Bravo 500 (M) or Echo 720 (M) - Cabrio EG (11) - Pristine WG (7+11) - Allegro 500 F (29) - Allette (33)	7.2 L/ha 5 L/ha 1 kg/ha 1.6 kg/ha 2.24 L/ha 5.6 kg/ha	Bravo, Echo: Also control alternaria fruit rot. May cause fruit injury if applied to green fruit. Allegro, Allette: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Allette: Apply at 14–21-day intervals.
Green fruit			
Blueberry aphids	- Pyganic EC 1.4 II (3) - Concept (3+4) - Assail 70 WP (4) - Admire 240 F (4) - Movento 240 SC (23) - Exirel (28)	2.32–4.65 L/ha 560 mL/ha 56–86 g/ha 175 mL/ha 220–365 mL/ha 0.75–1.5 L/ha	Aphids are rarely a problem on blueberries at this time. Monitor suckers and new shoots. Apply when population starts to build, but before winged aphids are seen. Pyganic: Toxic to bees. Avoid use when bees are actively foraging. For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Concept, Assail, Admire, Movento: Highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Apply postbloom after bees have been removed. Refer to label for specific bee toxicity statements. Do not apply Concept, Admire or Assail following a soil application of Admire or Alias for white grubs. Exirel: Do not tank-mix or make sequential applications with Cabrio, Pristine, Maestro or Supra Captan.
Obliquebanded leafroller (OBLR)	- Success (5) or Entrust 80 W (5) - Delegate WG (5) - Dipel 2X DF (11) or Bioprotec CAF (11) - Intrepid 240 F (18) - Altacor (28) - Exirel (28)	145–182 mL/ha 80–109 g/ha 100–200 g/ha 525–1,125 g/ha 1.4–2.8 L/ha 0.5 L/ha 285 g/ha 0.5–1.0 L/ha	Place pheromone traps in blueberries by early June. Apply insecticides for summer-generation larvae at 240–280 DDC after first sustained moth catch (base 6.1°C). See Appendix B: <i>Degree-Day Modeling</i>, page 291. Success, Entrust, Delegate: Re-apply as necessary on a 7–10-day schedule. Toxic to bees exposed to direct treatment, drift or residues on blooming plants. Dipel, Bioprotec: Works best on small larvae. Make at least 2 applications at 5–7-day intervals. For best results, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See <i>Using Organic and Biopesticide Products</i>, page 242. Intrepid: Has activity on eggs and young larvae. Altacor, Exirel: Apply when eggs are hatching and young larvae are present. Do not tank-mix or make sequential applications of Exirel with Cabrio, Pristine, Maestro or Supra Captan. Many of these products are also labelled for spanworms (known as inchworms or loopers) and other caterpillars. See product label for a complete list of registered uses.
Plum curculio	Exirel (28)	1.0–1.5 L/ha	Scout field edges for crescent-shaped scars on green blueberry fruit. Apply at the first sign of injury. Do not tank-mix or make sequential applications of Exirel with Cabrio, Pristine, Maestro or Supra Captan.
Japanese beetle adults	- Imidan 70-WP Instapak (1) - Admire 240 F (4) - Altacor (28) - Exirel (28)	1.6 kg/ha 350 mL/ha 285 g/ha 1.5 L/ha	Apply at the first sign of adult activity. Check preharvest intervals. Admire: Apply postbloom after bees have been removed. Do not make a foliar application following a soil application of a Group 4 insecticide. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Exirel: Do not tank-mix or make sequential applications with Cabrio, Pristine, Maestro or Supra Captan.
European chafer larvae Japanese beetle larvae	Spray once, as a high-volume spray on the soil at petal fall, green fruit or after harvest, using one of the products listed for European chafer larvae and Japanese beetle larvae at Petal fall .		

Disease or Insect	Product (Group)	Rate	Comments
Fruit ripening			
Spotted wing drosophila	• Exirel (28)	1.0–1.5 L/ha	Although Exirel is the first full registration for SWD, additional products will be registered shortly. See www.ontario.ca/spottedwing for emergency uses and new product registrations. Alternate products from different groups. Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into blueberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Weekly insecticides are recommended when fruit is ripening or ripe, and flies are present. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. See www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.
White-marked tussock moth	• Bioprotec CAF (11) or Foray 48BA (11)	4 L/ha 4 L/ha	White-marked tussock moth is a sporadic pest. Larvae devour foliage. Make 2 applications 2–5 days apart, when larvae are very small, usually just after bloom. A second generation may require control in late summer.
Botrytis fruit rot (grey mould)	• Supra Captan 80 WDG (M) or Maestro 80 DF (M) • Cantus WDG (7) • Scala SC (9) • Switch 62.5 WG (9+12) • Elevate 50 WDG (17) • Serenade MAX (44)	2.25 kg/ha 2.25 kg/ha 560 g/ha 2 L/ha 775–975 g/ha 1.7 kg/ha 3–6 kg/ha	Spray at 7–10-day intervals if botrytis grey mould was not well-controlled during bloom. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. For best results, use multiple applications or rotate with other products. See <i>Using Organic and Biopesticide Products</i>, page 242.
Anthracnose fruit rot	• Quash (3) • Switch 62.5 WG (9+12) • Cabrio EG (11) • Pristine WG (7+11)	180 g/ha 775–975 g/ha 1 kg/ha 1.3–1.6 kg/ha	Most infections take place during bloom. Fungicides at this time are not necessary if good control was achieved earlier.
Blueberry maggot	• Sevin XLR (1) • Imidan 70-WP Instapak (1) • Cygon 480-AG (1) or Lagon 480 E (1) • Malathion 85 E (1) • Assail 70 WP (4) • Admire 240 F (4) • GF-120 Fruit Fly Bait (5) • Movento 240 SC (23) • Exirel (28)	4 L/ha 1.6 kg/ha 830 mL/ha 825 mL/ha 550 mL/ha 136–160 g/ha 230–350 mL/ha 1.5 L/ha 365–435 mL/ha 1.0–1.5 L/ha	Monitor for blueberry maggot flies using yellow sticky traps. Blueberry maggot is not widespread in Ontario but it is regulated by the Canadian Food Inspection Agency in several regions (Charlottetown and Wainfleet townships) and on several blueberry farms. Growers in regulated areas should spray for this pest. Growers outside regulated areas should consider border sprays and use best management practices to prevent infestation. For more information, see Blueberry Maggot at www.ontario.ca/crops. Apply when first flies are trapped or when berries begin to turn blue, about July 5–15, depending on the area and season. Re-apply 5–12 days later, depending on the product. Protection is needed as long as adults are active. Residual activity is 10–12 days for Imidan and Cygon and 5–7 days for Sevin and Malathion. Cygon, Lagon: Do not use on crops destined for U.S. markets. Admire, Assail, Movento: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to the label for specific bee toxicity statements. Do not make a foliar application following a soil application of Admire or Assail. GF-120 Fruit Fly Bait: Begin applications when first flies are trapped or 2–3 weeks before fruit begins to ripen. Re-apply at least every 7 days. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. See <i>Using Organic and Biopesticide Products</i>, page 242. Exirel: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Do not tank-mix or make sequential applications with Cabrio, Pristine, Maestro or Supra Captan.

Disease or Insect	Product (Group)	Rate	Comments
Postharvest			
Leafhoppers	- Pyganic EC 1.4 II (3) - Admire 240 F (4)	2.32–4.65 L/ha 175 mL/ha	The sharp-nosed leafhopper is a vector of the blueberry stunt phytoplasma, a virus-like organism that causes blueberry stunt disease. Postharvest leafhopper control is important if blueberry stunt is a problem. Pyganic: For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Apply when pests are first observed; do not wait until plants are heavily infested. Re-apply if needed. Admire: Do not make a foliar application following a soil application of a Group 4 insecticide. Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.
European chafer larvae Japanese beetle larvae	Spray once, as a high-volume spray on the soil at petal fall, green fruit or after harvest, using one of the products listed for European chafer larvae and Japanese beetle larvae at Petal fall .		
Special sprays (These pests are not common in Ontario. Spray if and when monitoring indicates the need.)			
Lecanium scale	Movento 240 SC (23)	365–585 mL/ha	If lecanium scale is a problem, spray when crawlers are present, as indicated on black sticky tape. Movento: Use postbloom only.
Tipworm	Movento 240 SC (23)	365–435 mL/ha	
Gall midge	- Movento 240 SC (23) - Exirel (28)	365–435 mL/ha 750 mL–1 L/ha	Blueberry gall midge feed in buds and cause new leaves in shoot tips to be distorted, dried up or blackened. Movento: Use postbloom only. Exirel: Do not tank-mix or make sequential applications with Cabrio, Flint, Pristine, Maestro or Supra Captan.
Brown marmorated stink bug	- Malathion 85 E (1) - Actara 25 WG (4)	1 L/ha 280 g/ha	At time of printing this publication, this pest has not been detected in blueberries, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Malathion, Actara: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Do not apply during bloom or when bees are active.
Blueberry bud mite	Envirdor 240 SC (23)	1.3 L/ha	This pest has not been detected in Ontario, but is present in Michigan.
Septoria leaf spot	Proline 480 SC (3)	315 mL/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Leaf rust Valdensinia leaf spot	Proline 480 SC (3)	400 mL/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

Blueberry maggot is a regulated pest. New infestations must be reported to the Canadian Food Inspection Agency.

Blueberry maggot can spread to new areas in soil, harvest containers, or when infested fruit is purchased from another region and disposed of on your farm.

Use best management practices to prevent spread of blueberry maggot to new areas.

See www.ontario.ca/crops.

Table 4-9. Products Used on Blueberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress insects and mites						
Actara 25 WG	28408	thiamethoxam	4	3 days	12 hours	2
Admire 240 F	24094	imidacloprid	4	3 days ¹ /14 days ²	24 hours	1 ¹ /2 ¹
Alias 240 SC	28475	imidacloprid	4	14 days	24 hours	1
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours ³ / 48 hours ⁴	4
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	4
Concept	29611	imidacloprid + deltamethrin	3+4	14 days	12 hours	3
Cygon 480-AG	25651	dimethoate	1B	15 days	12 hours	2
Decis 5 EC	22478	deltamethrin	3	14 days	12 hours	—
Delegate WG	28778	spinetoram	5	3 days	12 hours	3
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	4
Entrust 80 W	27825	spinosad	5	3 days	when dry	3
Envior 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4 (max. 4.5 L/ha)
Foray 48BA	24978	<i>Bacillus thuringiensis</i>	11	—	12 hours	—
GF-120 Fruit Fly Bait	28336	spinosad	5	—	12 hours	5
Imidan 70-WP Instapak	29064	phosmet	1B	15 days	3 days ^{1a} /15 days ⁵	2
Intrepid 240 F	27786	methoxyfenozide	18	7 days	12 hours	4 (max. 2 L/ha)
Lagon 480 E	9382	dimethoate	1B	15 days	12 hours	2
Malathion 85 E	8372	malathion	1B	1 day	12 hours	3/4 ⁶
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.8 L/ha
Purespray Green Spray Oil 13 E	27666	mineral oil	NC	dormant application	12 hours	1
Pyganic EC 1.4 II	30164	pyrethrins	3	—	12 hours	8
Rimon 10 EC	28881	novaluron	15	8 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days	12 hours	—
Success	26835	spinosad	5	3 days	when dry	3
Superior 70 Oil	9542 14981	mineral oil	NC	dormant application	12 hours	1

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. — = Information is not specified on the product label.

¹ Foliar application.

² Soil application.

³ General re-entry.

⁴ Hand pruning.

⁵ Pick your own harvest.

⁶ Maximum 3 applications for brown marmorated stink bug or 4 applications for fruitworm.

⁷ Hand harvest.

⁸ Personal protective equipment required for certain activities. See label.

Table 4-9. Products Used on Blueberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress diseases						
Aliette	27688	fosetyl al	33	1 day	24 hours	4
Allegro 500 F	27517	fluazinam	29	30 days	24 hours	4
Bravo 500	15723	chlorothalonil	M	54 days	48 hours	3
Cabrio EG	27323	pyraclostrobin	11	1 day	12 hours ² / 24 hours ¹	4
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Confine Extra	30648	phosphorous acid, mono- and di- potassium salts of	33	1 day	12 hours	5
Echo 720	29355	chlorothalonil	M	54 days	48 hours	3
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	40 days	12 hours	—
Funginex DC	27686	triforine	3	60 days	48 hours	3
Jade	24030	propiconazole	3	60 days	12 hours ³ /5 days ⁴	2
Lime Sulphur	16465	calcium polysulphide	M	dormant application	48 hours	1
Maestro 80 DF	26408	captan	M	2 days	72 hours	—
Mission 418 EC	28016	propiconazole	3	60 days	12 hours ³ /5 days ⁴	2
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	when dry ¹ / 24 hours ²	4
Proline 480 SC	28359	prothioconazole	3	7 days	24 hours	2
Quash	30402	metconazole	3	7 days	12 hours ³ / 72 hours ⁴	3
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	80 days	12 hours	1
Scala SC	28011	pyrimethanil	9	0 days	12 hours	2
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	72 hours	—
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Topas	30163	propiconazole	3	60 days	12 hours ³ /5 days ⁴	2

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. — = Information is not specified on the product label.

¹ Foliar application.

² Soil application.

³ General re-entry.

⁴ Hand pruning.

⁵ Pick your own harvest.

⁶ Maximum 3 applications for brown marmorated stink bug or 4 applications for fruitworm.

⁷ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Notes on Blueberry Diseases and Insects

For information on the activity of fungicides to blueberry diseases, see Table 4-10. *Activity of Fungicides on Blueberry Diseases* on this page. For information on the activity of insecticides on blueberry insects, see Table 4-11. *Activity of Insecticides on Blueberry Pests and Bees*, page 95.

Table 4-10. Activity of Fungicides on Blueberry Diseases

Use fungicides only for diseases listed on the product label for the crop and for the disease. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide group	Product	Mummy berry (shoot blight)	Phomopsis stem canker	Anthrachnose fruit rot	Botrytis fruit rot	Alternaria fruit rot	Phytophthora root rot
M	Bravo 500	1	2 *	2 *	1	1 *	0
M	Echo 720	1	2 *	2 *	1	1 *	0
M	Ferbam 76 WDG	1	—	—	1 *	1	0
M	Lime Sulphur	—	1	1	—	—	—
M	Maestro 80 DF	1 *	1	2	1 to 2 *	1	0
M	Supra Captan 80 WDG	1 *	1	2	1 to 2 *	1	0
3	Funginex DC	3 *	2	0	0	0	0
3	Jade	3 *	1	2	0	0	0
3	Mission 418 EC	3 *	1	2	0	0	0
3	Proline 480 SC	3 *	2	2	—	—	—
3	Quash	3 *	2 *	2 *	0	0	0
3	Topas	3 *	1	2	0	0	0
4	Ridomil Gold 480 SL	0	0	0	0	0	3 *
7	Cantus WDG	0	—	—	3 *	2	0
7+11	Pristine WG	1 to 2	3 *	3 *	3 *	2	0
9	Scala SC	—	—	1	3 *	—	0
9+12	Switch 62.5 WG	1	1	3 *	3 *	3	0
11	Cabrio EG	1	3 *	3 *	1	1	0
17	Elevate 50 WDG	0	0	0	3 *	0	0
29	Allegro 500 F	1 *	1 *	1 *	—	1	0
33	Aliette	0	2 *	2 *	—	2	2 *
33	Confine Extra	0	2	1 *	—	2	2
44	Serenade MAX	2 *	1	0	1 *	—	0

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations.

* (shaded area) = Disease is listed on the product label for control or suppression.

— = No information is available.

Adopted from several sources including Michigan State Fruit Management Guide 2011.

Table 4-11. Activity of Insecticides on Blueberry Pests and Bees

Use insecticides only for insects listed on the product label for the crop and for the insect. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide	Aphid	Blueberry maggot	Cranberry fruitworm Cherry fruitworm	Japanese beetle (adult)	Leafroller	Plum curculio	Scale insects	Spotted wing drosophila (adult)	White grubs (larva)	Bee toxicity
1A	Sevin XLR	—	2 *	2 *	3	1 *	1	1 *	1	0	HT
1B	Cygon 480-AG	2	3 *	3	—	—	1	—	3	0	HT
1B	Lagon 480 E	2	3 *	3	—	—	1	—	3	0	HT
1B	Imidan 70 WP	—	3 *	3	2	3	3	—	3	0	HT
1B	Malathion 85 E	1 *	2 *	2 *	1	1 *	2	—	3	0	HT
3	Decis 5 EC	—	3	—	—	2	1	—	3	0	HT
3	Pyganic EC 1.4 II	1 *	0	—	—	—	—	0	1	0	HT
4	Actara 25 WG	3	2	—	2	—	3	—	0	2	HT
4	Admire 240 F	3 *	2 *	0	2 *	—	—	—	0	2 *	HT
4	Alias 240 SC	3 *	2 *	0	1 *	—	—	—	0	2 *	HT
4	Assail 70 WP	3 *	3 *	2 *	2	—	1	—	1	0	MT
3+4	Concept	3 *	2	2	—	—	—	—	2	0	HT
5	Delegate WG	—	—	3	0	3 *	1	0	3	0	HT
5	GF-120 Fruit Fly Bait	0	2 *	0	0	0	0	0	—	0	HT
5	Entrust 80 W	—	3	3	0	3 *	0	0	3	0	HT
5	Success	—	3	3	0	3 *	0	0	3	0	HT
11	Dipel 2X DF	0	0	1	0	2 *	0	0	0	0	S
11	Bioprotec CAF	0	0	1	0	2 *	0	0	0	0	S
11	Foray 48BA	0	0	1	0	2 *	0	0	0	0	S
15	Rimon 10 EC	—	—	3 *	0	3	0	—	—	0	MT ¹
18	Intrepid 240 F	—	—	3 *	—	3 *	—	—	—	—	S
23	Movento 240 SC	3 *	3 *	—	—	—	—	3 *	0	0	HT
28	Altacor	0	—	3 *	1	3 *	0	0	0	0	S
28	Exirel	3 *	1 *	3 *	2 *	3 *	3 *	—	2 *	0	HT
NC	Purespray Green Spray Oil 13E	2	0	0	0	0	0	3 *	0	0	—
NC	Superior 70 Oil	2	0	0	0	0	0	3 *	0	0	—

0 = No control. 1 = Poor to fair control. 2 = Good control. 3 = Excellent control.

* (shaded area) = Pest is listed on the product label for control or suppression. — = No information is available.

Bee toxicity: HT = Highly toxic. MT = Moderately toxic. S = Relatively safe or non-toxic.

¹ Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area.

Adopted from several sources including Michigan State Fruit Management Guide 2011.

Currant and Gooseberry Calendar

Read the product label and follow all safety precautions.

Unless specified on the product label, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-12. *Products Used on Currants*, page 98.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to currants and gooseberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Just before blossoms open			
DO NOT APPLY INSECTICIDES WHILE CURRANTS OR GOOSEBERRIES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Sawfly (imported currant fruitworm)	• Diazinon 50 WSP (1) or Diazinon 500 E (1)	1 kg/1,000 L water 1 L/1,000 L water	Larvae quickly devour foliage at the green fruit stage. Gooseberries are the preferred host; black currants are not attacked. This is not the best timing for sawfly control but Diazinon is not registered after the first bloom opens.
Aphids	• Malathion 25 W (1) • Assail 70 WP (4)	2.0–2.5 kg/1,000 L water 56–86 g/ha	Currant blister aphid feeds on new growth, causing leaf curl and red blisters. Spray if aphids are abundant. Ensure good coverage of undersides of curled leaves. Do not apply during bloom of crops or weeds in treatment area.
Leaf spot	• Ferbam 76 WDG (M) • Copper 53 W (M) plus hydrated lime • Proline 480 SC (3)	6.75 kg/ha 5 kg/1,000 L plus 4 kg lime/1,000 L 315 mL/ha	Leaf spots develop on susceptible varieties, reducing yield and vigour. Rake or cultivate to bury old infected leaves before bud break. Spray at weekly intervals if weather is wet. Ferbam: For currants only; do not use on gooseberries. Proline: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Powdery mildew	• Microscopic Sulphur (M) • Mettle 125 ME (3) • Nova 40 W (3) • Pristine WG (7+11)	5 kg/ha 219–365 mL/ha 340 g/ha 1.6 kg/ha	Resistant varieties are available. See Table 4-13. <i>Disease Ratings on Selected Currant and Gooseberry Varieties</i> , page 99. Prune out infected twig tips in fall and avoid excessive nitrogen. If warm and humid conditions persist, spray weekly until fruit begins to colour. Apply before symptoms develop. Mettle: For gooseberries only. Do not use on currants. Pristine: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

Disease or Insect	Product (Group)	Rate	Comments
Botrytis grey mould	• Pristine WG (7+11) • Cantus WDG (7) • Scala SC (9) • Elevate 50 WDG (17) • Serenade MAX (44)	1.3–1.6 kg/ha 560 g/ha 2 L/ha 1.7 kg/ha 3–6 kg/ha	Botrytis infection during bloom causes early fruit drop, or “runoff” in currants. Apply fungicides at 7–10-day intervals during bloom. Scala: For gooseberries only; do not use on currants. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Bloom			
Botrytis grey mould	Apply one of the products listed for botrytis grey mould at Just before blossoms open .		
Green fruit			
Currant fruit fly	• Malathion 25 W (1)	2.0–2.5 kg/1,000 L water	Controls adult flies, which lay eggs on green fruit. Larvae infest fruit, causing it to ripen prematurely. Spray after bloom where this pest has been a problem in the past or use yellow sticky traps to monitor when adults are active. Make 2 applications, 10 days apart. Malathion is most effective when temperature is above 20°C.
Leaf spot	• Copper 53 W (M) plus hydrated lime • Proline 480 SC (3)	5 kg/1,000 L plus 4 kg lime/1,000 L 315 mL/ha	Apply at weekly intervals in the spring if weather is wet, but not within 14 days of harvest. Proline: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Powdery mildew	• Microscopic Sulphur (M) • Mettle 125ME (3) • Nova 40 W (3) • Pristine WG (7+11)	5 kg/ha 219–365 mL/ha 340 g/ha 1.6 kg/ha	Resistant varieties are available. See Table 4-13. <i>Disease Ratings on Selected Currant and Gooseberry Varieties</i> , page 99. Prune out infected twig tips in fall and avoid excessive nitrogen. If warm and humid conditions persist, spray weekly until fruit begins to colour. Apply before symptoms develop. Mettle: For gooseberries only; do not use on currants. Pristine: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Aphids	• Malathion 25 W (1) • Assail 70 WP (4) • Admire 240 F (4) • Movento 240 SC (23)	2.5 kg/1,000 L water 56–86 g/ha 175 mL/ha 220–365 mL/ha	Monitor for leaf curling on new growth. Spray red and white currants immediately after fruit is picked. Admire: Also labelled as a soil application for white grubs. See label for this additional use. Do not use both soil applications and foliar sprays in the same year. Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for bee toxicity statements. Movento: Postbloom use only.
Leafhoppers	• Malathion 25 W (1) • Admire 240 F (4)	2.5 kg/1,000 L water 175 mL/ha	Monitor for leaf curling on new growth. Spray red and white currants immediately after fruit is picked. Admire: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.
Obliquebanded leafroller	• Success (5) or Entrust 80 W (5) • Dipel 2X DF (11) or Bioptoc CAF (11) • Intrepid 240 F (18) • Exirel (28)	145–182 mL/ha 80–109 g/ha 525–1,125 g/ha 1.4–2.8 L/ha 0.5 L/ha 0.5–1.0 L/ha	This pest is rarely a problem on currants and gooseberries. Success, Entrust, Intrepid, Exirel: Also control spanworms or other leafrollers. See label for complete list of pests. Dipel, Bioprotec: Work best on very small larvae. Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See <i>Using Organic and Biopesticide Products</i> , page 242. Exirel: Do not tank-mix or make sequential applications with Pristine or Copper.
Postharvest			
Aphids	Use one of the products listed for aphids at Green fruit .		
Leafhoppers	Use one of the products listed for leafhoppers at Green fruit .		
Japanese beetle	• Altacor (28) • Exirel (28)	285 g/ha 1.0–1.5 L/ha	Japanese beetle is not usually a problem on currants. Apply pre- or postharvest if necessary. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with Pristine or Copper.
Leaf spot	If leaf spot or powdery mildew continues to be a problem, spray after harvest with a product listed for these diseases at Green fruit to avoid premature defoliation.		
Powdery mildew			

Table 4-12. Products Used on Currants and Gooseberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress insects and mites						
Admire 240 F	24094	imidacloprid	4	3 days	24 hours	2 ¹
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours ² /48 hours ³	4
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	4 hours	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Diazinon 500 E	11889	diazinon	1A	prebloom	6 days	—
Diazinon 50 WSP	29976	diazinon	1A	prebloom	6 days	—
Entrust 80 W	27825	spinosad	5	3 days	when dry	3
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4
Intrepid 240 F	27786	methoxyfenozone	18	7 days	12 hours	4
Malathion 25 W	14656	malathion	1B	3 days	12 hours	—
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max 1.8 L/ha
Success	26835	spinosad	5	3 days	when dry	3
Products used to control or suppress diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Copper 53 W	9934	tribasic copper sulphate	M	1 day	48 hours	4
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 75 WDG ⁴	20136	ferbam	M	14 days	12 hours	—
Mettle 125ME ⁵	30673	tetraconazole	3	14 days	12 hours	2
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	8
Nova 40 W	22399	myclobutanil	3	6 days	12 hours ² /6 days ^{6,7}	3
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	when dry ² /29 days ⁶	4
Proline 480 SC	28359	prothioconazole	3	7 days	24 hours	2
Scala SC ⁵	28011	pyrimethanil	9	7 days	12 hours	3
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—

— = Information is not specified on the product label. M = Multi-site fungicides.

¹ Foliar application.

² General re-entry.

³ Hand pruning.

⁴ Registered for currants only, not gooseberries.

⁵ Registered for gooseberries only, not currants.

⁶ Hand harvest.

⁷ Hand training, tying.

Table 4-13. Disease Ratings on Selected Currant and Gooseberry Varieties

Type	Variety	Mildew resistance	Rust resistance
Black currant	Ben Alder	resistant	very susceptible
	Ben Connan	resistant	moderately resistant
	Ben Sarek	resistant	moderately resistant
	Titania	immune	immune
Red currant	Red Lake	susceptible	susceptible
	Rovada	resistant	moderately resistant
	Jonkheer van Tets	moderately resistant	resistant
Gooseberry	Captivator	moderately resistant	—
	Invicta	moderately resistant	moderately resistant
	Hinnonmaki Red	resistant	moderately resistant

Resistant = Does not show symptoms of rust (only Titania has genetic resistance). Moderately resistant = Shows symptoms at low frequency, yield not affected. Susceptible = Noticeable levels of rust infection, not affecting yield. Very susceptible = Severe infection, affecting yield. — = Information is not available.

Source:

Adam Dale, *HortTechnology* 10(3) 2000, pg. 553.

Hummer and Barney, *HortTechnology* 12(3) 2002, pp. 382–383; or, *Currants, Gooseberries, Jostaberries, Guide for Growers*, Food Products Press 2005.

Dick McGinnis, McGinnis Berry Crops, B.C., personal communication.

Elderberries

Elderberries have few insect and disease pests. However, as a part of the bushberry crop group, products registered for bushberries can be used on elderberries (Table 4-14. *Pest Management Products for Elderberries*, page 100). Scout for insects and diseases. Apply controls as needed.

Read the product label and follow all safety precautions.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to elderberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Table 4-14. Pest Management Products for Elderberries

Read the product label and follow all safety precautions.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Pest	Common name	Product (Group)	Rate	Preharvest interval	Minimum re-entry	Max. number applications per season	Comments
Aphids	acetamiprid	Assail 70 WP (4)	56–86 g/ha	7 days	12 hours ¹ / 48 hours ²	4	Do not apply from bud stage to bloom, or when bees are actively foraging.
	imidacloprid	Admire 240 SC (4)	175 mL/ha	3 days ³ / 14 days ⁴	24 hours	2 ¹ /1 ⁴	Admire: Also labelled as a soil application for white grubs. See label for this additional use.
	spirotetramat	Movento 240 SC (23)	220–365 mL/ha	7 days	12 hours	max. 1.8 L/ha	Use postbloom only.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand pruning.

³ Foliar application.

⁴ Soil application.

⁵ Hand training, tying.

⁶ Hand harvest.

Table 4-14. Pest Management Products for Elderberries (cont'd)

Pest	Common name	Product (Group)	Rate	Preharvest interval	Minimum re-entry	Max. number applications per season	Comments
Leafrollers and spanworms	spinosad	Success (5) or Entrust 80 W (5)	145–182 mL/ha 80–109 g/ha	3 days	when dry	3	Use pheromone traps and spray as soon as possible after peak trap catch, or when very small larvae are present.
	<i>Bacillus thuringiensis</i>	Dipel 2X DF (11)	525–1,125 g/ha	0 days	4 hours	—	Dipel, Bioprotec: Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See <i>Using Organic and Biopesticide Products</i> , page 242. Exirel: Do not tank-mix or make sequential applications with Pristine.
		Bioprotec CAF (11)	1.4–2.8 L/ha	0 days	12 hours	—	
	methoxyfenozide	Intrepid 240 F (18)	0.5 L/ha	7 days	12 hours	4	
	chlorantraniliprole	Altacor (28)	285 g/ha	1 day	12 hours	3	
	cyantraniliprole	Exirel (28)	0.5–1.0 L/ha	3 days	12 hours	4	
Weevils	thiamethoxam	Actara 25 WG (4)	210–280 g/ha	3 days	12 hours	2	Do not apply during bloom or when bees are active. Apply to foliage to control adult weevils.
Brown marmorated stink bug	thiamethoxam	Actara 25 WG (4)	280 g/ha	3 days	12 hours	2	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. At time of printing this publication, this pest has not been detected in fruit crops, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for information. Do not apply during bloom or when bees are active.
Spotted wing drosophila	cyantraniliprole	Exirel (28)	1.0–1.5 L/ha	3 days	12 hours	4	Although Exirel is the first full registration for SWD, additional products will be registered shortly. See www.ontario.ca/spottedwing for emergency uses and new product registrations. Alternate products from different groups. Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into fruit as they are ripening. Elderberries are very susceptible to SWD. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Check www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.
Japanese beetle	chlorantraniliprole	Altacor (28)	285 g/ha	1 day	12 hours	3 (max. 645 g/ha)	Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	cyantraniliprole	Exirel (28)	1.5 L/ha	3 days	12 hours	4	

— = Information is not specified on the product label.

¹ General re-entry.² Hand pruning.³ Foliar application.⁴ Soil application.⁵ Hand training, tying.⁶ Hand harvest.

Table 4-14. Pest Management Products for Elderberries (cont'd)

Pest	Common name	Product (Group)	Rate	Preharvest interval	Minimum re-entry	Max. number applications per season	Comments
Anthracnose	metconazole	Quash (3)	180 g/ha	7 days	12 hours ¹ / 72 hours ⁵	3	Apply when conditions favour disease, prior to infection. Allegro: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	boscalid + pyraclostrobin	Pristine WG (7+11)	1.3–1.6 kg/ha	0 days	when dry ¹ / 24 hours ⁶	4	
	fluazinam	Allegro 500 F (29)	2.24 L/ha	30 days	24 hours	4	
Bacterial blight	<i>Bacillus subtilis</i>	Serenade MAX (44)	1–3 kg/ha	0 days	12 hours	—	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242.
Botrytis	fenhexamid	Elevate 50 WDG (17)	1.7 kg/ha	1 day	4 hours	4	Begin applications at 10% bloom. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242.
	boscalid	Cantus WDG (7)	560 g/ha	0 days	12 hours	4	
	boscalid + pyraclostrobin	Pristine WG (7+11)	1.3–1.6 kg/ha	0 days	when dry ¹ / 24 hours ⁶	4	
	<i>Bacillus subtilis</i>	Serenade MAX (44)	3–6 kg/ha	0 days	12 hours	—	
Phomopsis	metconazole	Quash (3)	180 g/ha	7 days	12 hours ¹ / 72 hours ⁵	3	Apply when conditions favour disease, prior to infection. Quash: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	boscalid + pyraclostrobin	Pristine WG (7+11)	1.6 kg/ha	0 days	when dry ¹ / 24 hours ⁶	4	
Leaf spot	prothioconazole	Proline 480 SC (3)	315 mL/ha	7 days	3 days	2	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

— = Information is not specified on the product label.

¹ General re-entry.² Hand pruning.³ Foliar application.⁴ Soil application.⁵ Hand training, tying.⁶ Hand harvest.

Summer-fruiting Raspberry Calendar

Read the product label and follow all safety precautions.

Unless specified on the product label, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-15. *Products Used on Raspberries*, page 110.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to raspberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Before planting			
Root lesion nematode Phytophthora root rot	• MustGrow (NC)	980–2,240 kg/ha	MustGrow is a pelleted formulation of oriental mustard seed meal. Apply with a calibrated spreader, in early spring, when soil temperatures are above 10°C, but at least 2 weeks before planting. Incorporate into the upper soil layer to a depth of 10–15 cm, followed by irrigation to ensure the top 10–15 cm of soil is well-moistened. Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Delayed dormant to green tip			
Spur blight Cane blight	• Lime Sulphur (M)	26 L/1,000 L water	This spray reduces overwintering inoculum and is the first step in a good disease control program. Spray enough water to drip off the plants. Do not use later than ¼-inch green.
Prebloom (until blossoms open)			
Anthracnose Spur blight	• Ferbam 76 WDG (M) • Tanos 50 DF (11+27)	2.5 kg/1,000 L water 840 g/ha	Protect new growth. Apply when new canes are 25–30 cm tall and just before first bloom.
Powdery mildew	• Senator 70 WP (1) • Nova 40 W (3)	1.1 kg/ha 340 g/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days.
Raspberry sawfly	• Diazinon 50 WSP (1)	1 kg/1,000 L water	These green bristly larvae feed between the veins on new growth causing long holes and shredding. Apply when damage appears, but before first bloom. Diazinon also controls aphids and raspberry fruitworm.
Raspberry fruitworm	• Malathion 25 W (1) Diazinon 50 WSP (1)	4–5 kg/1,000 L water 1 kg/1,000 L water	These small brown beetles feed on new growth and blossom clusters. Larvae infest the fruit cup. Spray to control adults when damage appears but before first bloom. Repeat in 7–10 days where there is a history of injury.

Disease or Insect	Product (Group)	Rate	Comments
Obliquebanded leafroller	• Delegate WG (5) • Success (5) - or Entrust 80 W (5) • Foray 48BA (11) - or Bioprotec CAF (11) - or Dipel 2X DF (11)	200 g/ha 145–182 mL/ha 80–109 g/ha 1.4–2.8 L/ha 1.4–2.8 L/ha 525–1,125 g/ha	Leafrollers are not usually a problem in Ontario. Delegate, Success, Entrust: Apply to eggs and small larvae. Dipel, Foray, Bioprotec: Work best on small larvae. Repeat at 3–7-day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See <i>Using Organic and Biopesticide Products</i> , page 242.
Clipper weevil	• Malathion 25 W (1)	4–5 kg/1,000 L water	Shake blossom clusters over a tray or dish. Spray if small weevils and clipped buds are easily observed. This pest is more common where strawberries are grown nearby.
Aphids, leafhoppers	• Pyganic EC 1.4 II (3)	2.32–4.65 L/ha	For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Apply when pests are first observed; do not wait until plants are heavily infested. Re-apply, if needed. Toxic to bees. Avoid use when bees are actively foraging.
Two-spotted spider mite	• Apollo SC (10) • Kanemite 15 SC (20) • Acramite 50 WS (UN)	500 mL/ha 2.07 L/ha 851 g/ha	Beneficial mites can be introduced to prevent mite build-up. Thorough spray coverage of the lower leaf surface is required. Apollo: Kills mite eggs and young nymphs. Apply when mites are mostly in the egg stage. Acramite, Kanemite: Act quickly on contact with mites.
Bloom			
DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Botrytis grey mould	• Supra Captan 80 WDG (M) - or Maestro 80 DF (M) • Senator 70 WP (1) • Rovral WDG (2) • Cantus WDG (7) • Pristine WG (7+11) • Scala SC (9) • Switch 62.5 WG (9+12) • Elevate 50 WDG (17) • Serenade MAX (44)	2.5 kg/ha 2.5 kg/ha 1.1 kg/ha 2 kg/ha 560 g/ha 1.3–1.6 kg/ha 2 L/ha 775–975 g/ha 1.7 kg/ha 3–6 kg/ha	Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and if the weather is wet. Re-apply every 7 days. Supra Captan, Maestro: The rate on blackberry is 2.25 kg/ha. These products also control spur blight. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. For best results, use multiple applications or rotate with other products. See <i>Using Organic and Biopesticide Products</i> , page 242.
Fire blight	• Bloomtime Biological FD (NC)	375–500 g/ha	Bloomtime: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267 Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15–20% bloom, second application at full bloom to petal fall. Refer to label for specific handling and storage requirements. See <i>Using Organic and Biopesticide Products</i> , page 242.
Powdery mildew	Use one of the products listed for powdery mildew at Prebloom (before blossoms open) .		
Green fruit			
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF (11+27)	840 g/ha	Ensure spray coverage of primocanes in the row. Keep rows narrow by mowing primocanes as they emerge at the row edges. Supra Captan and Maestro used at this timing will also control spur blight.
Obliquebanded leafroller	Use one of the products listed for obliquebanded leafroller at Prebloom (until blossoms open) .		
Japanese beetle	• Sevin XLR (1)	5.25 L/ha	Apply when adults appear and repeat as necessary at 7–10-day intervals.
Rose chafers	• Malathion 25 W (1)	4–5 kg/1,000 L water	Spray when adults are active.

Disease or Insect	Product (Group)	Rate	Comments
Leafhoppers	• Malathion 25 W (1) • Pyganic EC 1.4 II (3) • Admire 240 F (4) - or Alias 240 SC (4)	4–5 kg/1,000 L water 2.32–4.65 L/ha 175 mL/ha 175 mL/ha	Potato leafhopper can be a problem when nearby hay fields are mowed. New plantings are especially susceptible. Monitor for small green nymphs on lower leaf surface. Leafhoppers feed on primocane leaves and cause new growth to turn yellow and curl under. Spray when nymphs are present and symptoms are evident. Pyganic: For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Re-apply, if needed. Also controls aphids. Admire, Alias: Highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Do not apply prebloom, during bloom, or when bees are actively foraging. Refer to label for specific bee toxicity statements. Apply in 300 L water as a foliar spray. Under high pressure, may provide suppression rather than control. Also controls aphids.
Raspberry cane borer Red-necked cane borer	• Admire 240 F (4) - or Alias 240 SC (4)	467 mL/ha 467 mL/ha	Raspberry cane borer makes 2 rings of puncture marks around the top of the cane, causing the primocane to wilt. Spray to control beetles when damage is first observed. Red-necked cane borer attacks the lower primocane, causing canes to break off 0.5–1 m above the ground later in the season. If there is a history of this pest, spray when beetles are active. Admire, Alias: Do not apply prebloom, during bloom, or when bees are actively foraging. Apply in 300 L water/ha as a foliar spray. Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
White grubs (larvae of European chafer)	• Admire 240 F (4) - or Alias 240 SC (4)	1.2 L/ha 1.2 L/ha	Reduction in numbers only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Apply in young plantings where populations are high. Apply just prior to egg hatch (shortly after adults are active) to damp soil in the plant row and in the alleys. Use in 200 L water/ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application. Do not apply prebloom, during bloom, or when bees are actively foraging.
Two-spotted spider mite	• Kanemite 15 SC (20) • Acramite 50 WS (UN)	2.07 L/ha 851 g/ha	These products act quickly on contact with mites. Thorough coverage of both leaf surfaces is necessary for good control.
Preharvest and harvest			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into raspberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.		
Spanworms	• Success (5) - or Entrust 80 W (5)	145–182 mL/ha 80–109 g/ha	Spanworms, also known as inch-worms or loopers, appear just before harvest on raspberry fruit.
Botrytis grey mould	• Supra Captan 80 WDG (M) - or Maestro 80 DF (M) • Senator 70 WP (1) • Rovral WDG (2) • Cantus WDG (7) • Pristine WG (7+11) • Scala SC (9) • Switch 62.5 WG (9+12) • Elevate 50 WDG (17) • Serenade MAX (44)	2.5 kg/ha 2.5 kg/ha 1.1 kg/ha 2 kg/ha 560 g/ha 1.3–1.6 kg/ha 2 L/ha 775–975 g/ha 1.7 kg/ha 3–6 kg/ha	Although bloom is the most important time to control botrytis grey mould, preharvest sprays are required if the weather is wet. Supra Captan, Maestro: Also controls spur blight. The rate on blackberry is 2.25 kg/ha. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. For best results, use multiple applications or in rotation with other products. See <i>Using Organic and Biopesticide Products</i>, page 242.

Disease or Insect	Product (Group)	Rate	Comments
Postharvest			
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF (11+27)	840 g/ha	Apply once or twice after harvest to protect primocanes. Ensure spray coverage of primocanes in the row. Narrow rows and good weed control will reduce disease pressure in the row by allowing air flow and faster drying.
Leafhoppers	• Malathion 25 W (1) • Admire 240 F (4) or Alias 240 SC (4) • Surround WP (NC)	4–5 kg/1,000 L water 175 mL/ha 175 mL/ha 25 kg/ha	Admire, Alias: Do not apply when bees are actively foraging. Apply in 300 L water as a foliar spray. Under high pressure, may provide suppression rather than control. Also controls aphids. Surround: Apply at 7–14-day intervals when leafhoppers are first detected by monitoring. For early applications, use 25 kg per 500 L of water. Once a base coat is established, rate can be reduced for follow-up applications to 12.5 kg per 500 L of water. Surround is not recommended when fruit is present or during bloom. See <i>Using Organic and Biopesticide Products</i> , page 242.
Two-spotted spider mite	• Agri-Mek 1.9% EC (6) • Kanemite (20) • Nexter (21) • Acramite 50 WS (UN)	1 L/ha 2.07 L/ha 600 g/ha 851 g/ha	Check lower leaf surface for mites and webbing. Thorough spray coverage of the lower leaf surface is required. Beneficial mites can be introduced to prevent mite build-up. Alternate miticides between years.
White grubs (larvae of European chafer)	• Admire 240 F (4) or Alias 240 SC (4)	1.2 L/ha 1.2 L/ha	Reduction in numbers only. Apply in young plantings where populations are high. Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply when bees are actively foraging. Read the specific bee toxicity statements on the label. Apply to damp soil in the plant row and in the alleys. Use in 200 L water/ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application.
Special sprays: early spring and/or fall			
Raspberry crown borer	• Diazinon 500 E (1) or Diazinon 50 WSP (1) • Altacor (28)	1 L/1,000 L water 1 kg/1,000 L water 215–285 g/ha	If more than 5% of the crowns are infested, spray lower portions of canes and the crown area. Treat infested plantings at least 2 years in a row. Diazinon: Apply in 4,000–5,000 L of water/ha as a drench to crowns and base of plants. Apply in spring to control young larvae before they tunnel into crowns and when new growth is about 10 cm above ground. Do not apply after first bloom. Altacor: Apply to foliage when adults moths are active, usually July–September. Spray to control young larvae as eggs hatch and before they tunnel into the root, crown or canes. Re-apply, if necessary, at 14-day intervals.
Phytophthora root rot	• Ridomil Gold 480 SL (4) • Aliette (33) or Phostrol (33)	37 mL/100 m of row 5.50 kg/ha 5.2 L/ha	Ridomil: In new, non-bearing plantings, apply as a soil drench after planting in a 1 m band centred over the row. Re-apply mid to late October (before the ground is frozen). In established plantings, apply in the fall only. Use at least 2,500 L of water per ha. Aliette, Phostrol: Use as a preventive treatment. Do not tank-mix with copper, foliar fertilizers or surfactants. Maximum of 4 applications per season: 2 in the spring and 2 in the fall. Spring application: Apply after bud break at 7 cm of new growth. Re-apply 3–4 weeks later, if needed. Do not apply within 60 days of harvest. Fall application: Apply when conditions favour disease (high soil moisture and cool temperatures). Re-apply 3–4 weeks later, if needed. Do not apply 30 days before leaf drop. Phostrol: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

Fall-bearing Raspberry Calendar (primocane fruiting)

This calendar is for primocane-fruiting raspberry varieties that fruit on the tips of the current year's growth, and are mowed annually.

Read the product label and follow all safety precautions.

Unless specified on the product label, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-15. *Products Used on Raspberries*, page 110.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to raspberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Before planting			
Root lesion nematode Phytophthora root rot	• MustGrow (NC)	980–2,240 kg/ha	MustGrow is a pelleted formulation of oriental mustard seed meal. Apply with a calibrated spreader, in early spring, when soil temperatures are above 10°C, but at least 2 weeks before planting. Incorporate into the upper soil layer to a depth of 10–15 cm, followed by irrigation to ensure the top 10–15 cm of soil is well-moistened. Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Primocanes emerge			
Anthracnose Spur blight	• Ferbam 76 WDG (M) • Tanos 50 DF (11+27)	2.5 kg/1,000 L water 840 g/ha	Cane diseases are rarely a problem in primocane-fruiting varieties because old canes are mowed down in spring, removing most inoculum. If cane diseases are a perennial problem, apply when new canes are 25–30 cm tall and again in 10 days. Continue at 10–14-day intervals until just before first bloom.
Raspberry sawfly	• Diazinon 50 WSP (1)	1 kg/1,000 L water	These green bristly larvae feed between the veins on new growth, causing long holes and shredding. Apply when damage appears, but before first bloom. Also controls aphids and raspberry fruitworm.
Obliquebanded leafroller	• Delegate WG (5) • Success (5) or Entrust 80 W (5) • Foray 488A (11) or Bioprotec CAF (11) or Dipel 2X DF (11)	200 g/ha 145–182 mL/ha 80–109 g/ha 1.4–2.8 L/ha 1.4–2.8 L/ha 525–1,125 g/ha	Leafrollers are not usually a problem in Ontario. Considerable damage can occur without crop loss. Delegate, Success, Entrust: Apply to eggs and small larvae. Dipel, Foray and Bioprotec: Work best on small larvae. Re-apply at 3–7-day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See <i>Using Organic and Biopesticide Products</i> , page 242.

Disease or Insect	Product (Group)	Rate	Comments
Two-spotted spider mite	• Apollo SC (10)	500 mL/ha	Beneficial mites can be introduced to prevent mite build-up. Thorough spray coverage of the lower leaf surface is required. Apollo: Kills mite eggs and young nymphs. Apply early in the season. Acramite, Kanemite: These products act quickly on contact with mites. Apply when monitoring indicates mites are building up, and mostly in the nymph stages.
	• Kanemite 15 SC (20)	2.07 L/ha	
	• Acramite 50 WS (UN)	851 g/ha	
Prebloom			
Japanese beetle	• Sevin XLR (1)	5.25 L/ha	Apply when adults are active. Re-apply at 7–10-day intervals, if needed. Do not apply during bloom.
Rose chafers	• Malathion 25 W (1)	4–5 kg/1,000 L water	Apply when adults are active. Do not apply during bloom.
Leafhoppers	• Malathion 25 W (1)	4–5 kg/1,000 L water	Potato leafhopper can be a problem when nearby hay fields are mowed. New plantings are especially susceptible. Monitor for small green nymphs on lower leaf surface. Leafhoppers feed on primocane leaves and cause new growth to turn yellow and curl under. Spray when nymphs are present and symptoms are evident. Do not apply during bloom. Pyganic: For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Re-apply if needed. Also controls aphids. Toxic to bees. Avoid use when bees are actively foraging.
	• Pyganic EC 1.4 II (3)	2.32–4.65 L/ha	
Bloom (mid-July to August)			
DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Botrytis grey mould	• Supra Captan 80 WDG (M)	2.5 kg/ha	Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and if the weather is wet. Re-apply at 7–10-day intervals. Supra Captan, Maestro: Also control spur blight. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. For best results, use multiple applications or in rotation with other products. See <i>Using Organic and Biopesticide Products</i> , page 242.
	or Maestro 80 DF (M)	2.5 kg/ha	
	• Senator 70 WP (1)	1.1 kg/ha	
	• Rovral WDG (2)	2 kg/ha	
	• Cantus WDG (7)	560 g/ha	
	• Pristine WG (7+11)	1.3–1.6 kg/ha	
	• Scala SC (9)	2 L/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	
• Serenade MAX (44)	3–6 kg/ha		
Fire blight	• Bloomtime Biological FD (NC)	375–500 g/ha	Bloomtime: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15–20% bloom, and second application at full bloom to petal fall. Refer to the label for specific handling and storage requirements. See <i>Using Organic and Biopesticide Products</i> , page 242.
Bloom to green fruit			
Raspberry cane borer	Products registered for cane borers cannot be used during bloom. Therefore, they are not suitable for primocane fruiting raspberries which have a prolonged bloom period.		
Red-necked cane borer	Prune out and remove old canes during the dormant period to reduce populations of larvae inside the cane. Remove all nearby wild raspberries, because these are good hosts for cane borers.		
Aphids, leafhoppers	• Pyganic EC 1.4 II (3)	2.32–4.65 L/ha	Toxic to bees. Avoid use when bees are actively foraging. For best results, use high rate, adjust spray solution to pH of 5.5–7.0, and apply promptly after mixing. If possible, apply in the early morning or evening hours. Apply when pests are first observed and re-apply, if needed.
Two-spotted spider mite	• Kanemite 15 SC (20)	2.07 L/ha	Beneficial mites can be introduced to prevent mite build-up. Thorough spray coverage of the lower leaf surface is required. Apply when population is mostly in the nymph stages. Do not spray when bees are active.
	• Acramite 50 WS (UN)	851 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Preharvest and harvest			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into raspberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Fall-bearing raspberries are especially susceptible to this pest. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.		
Botrytis grey mould	Although bloom is the most important time to control botrytis grey mould, preharvest sprays are required if the weather is wet. Use one of the products listed for botrytis grey mould at Bloom (mid-July to August) .		
Powdery mildew	• Senator 70 WP (1) • Nova 40 W (3)	1.1 kg/ha 340 g/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days.
Special sprays: early spring and/or fall			
Raspberry crown borer	Prune out old canes close to the ground when plants are dormant. If this pest is a problem, use one of the products listed for raspberry crown borer under Summer-fruiting Raspberries, Special sprays , page 106.		
Yellow rust	• Mission 418 EC (3) or Jade (3) or Topas (3)	300 mL/ha 500 mL/ha 500 mL/ha	Apply at first sign of disease and re-apply 14 days later.
Brown marmorated stink bug	• Malathion 85 E (1)	1.3 L/ha	At time of printing this publication, this pest has not been detected in raspberries, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Malathion: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Phytophthora root rot	If this disease is a problem, use one of the products listed for phytophthora root rot under Summer-fruiting Raspberries, Special sprays , page 106.		

Table 4-15. Products Used on Raspberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry** period is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress insects and mites						
Acramite 50 WS	27925	bifenazate	UN	1 day	12 hours	1
Admire 240 F	24094	imidacloprid	4	4 days ¹ /14 days ²	24 hours	3 ¹ /1 ²
Agri-Mek 1.9% EC	24551	abamectin	6	postharvest	12 hours	2
Alias 240 SC	28475	imidacloprid	4	4 days ¹ /14 days ²	24 hours	3 ¹ /1 ²
Altacor	28981	chlorantraniliprole	28	3 days	12 hours	2/3 ³ (max. 645 g/ha)
Apollo SC	21035	clofentezine	10	15 days	12 hours	1
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Delegate WG	28778	spinetoram	5	1 day	12 hours	3
Diazinon 500 E	11889	diazinon	1B	prebloom	6 days	—
Diazinon 50 WSP	29976	diazinon	1B	prebloom	6 days	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust 80 W	27825	spinosad	5	3 days	when dry	3
Foray 48BA	24978	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Kanemite 15 SC	28641	acequinocyl	20B	1 day	12 hours	—
Malathion 25 W	14656	malathion	1B	1 day	12 hours	—
Malathion 85 E	8372	malathion	1B	1 day	12 hours	2 (for BMSB)
Nexter	25135	pyridaben	21	postharvest	24 hours	2
Pyganic EC 1.4 II	30164	pyrethrins	3	—	12 hours	8
Sevin XLR	27876	carbaryl	1A	11 days	12 hours	—
Success	26835	spinosad	5	3 days	when dry	3
Surround WP	27469	kaolin	NC	1 day	12 hours	—
Vydate L	17995	oxamyl	1A	postharvest	72 hours	1

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ Foliar application.

² Soil application.

³ Maximum 2 applications per year at high rate or 3 application at low rate.

⁴ General re-entry.

⁵ After activation with water in soil.

⁶ Hand training, tying and hand harvest.

⁷ Hand pruning and thinning.

* Personal protective equipment is required for certain activities. See label.

Table 4-15. Products Used on Raspberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress diseases						
Aliette	27668	fosetyl al	33	60 days	when dry	4
Bloomtime Biological FD	28436	<i>Pantoea agglomerans</i>	NC	0 days	4 hours	2
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	prebloom		3
Jade	24030	propiconazole	3	30 days	4 hours ¹ / 72 hours ⁴	2
Lime Sulphur	16465	calcium polysulphide	M	¼- inch green	48 hours	—
Maestro 80 DF	26408	captan	M	2 days	72 hours	—
Mission 418 EC	28016	propiconazole	3	30 days	4 hours ¹ / 72 hours ⁴	2
MustGrow	30263	oriental mustard seed meal	NC	—	24 hours ⁵	1
Nova 40 W	22399	myclobutanil	3	6 days	12 hours ¹ / 6 days ⁶	3
Phostrol	30449	mono- and di-basic sodium, potassium and ammonium phosphites	33	1 day	12 hours	4
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	when dry ¹ / 24 hours ^{6,7}	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	postharvest	12 hours	1
Rovral WDG	24709	iprodione	2	1 day	12 hours	8
Scala SC	28011	pyrimethanil	9	0 days	12 hours	2
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	72 hours	—
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Tanos 50 DF	27435	cymoxanil + famoxadone	11+27	9 days	9 days	3
Topas	30163	propiconazole	3	30 days	12 hours	2

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ Foliar application.² Soil application.³ Maximum 2 applications per year at high rate or 3 application at low rate.⁴ General re-entry.⁵ After activation with water in soil.⁶ Hand training, tying and hand harvest.⁷ Hand pruning and thinning.

* Personal protective equipment is required for certain activities. See label.

Notes on Raspberry Diseases and Insects

For information on the activity of fungicides on raspberry diseases, see Table 4-16. *Activity of Fungicides on Raspberry Diseases*, on this page.

For information on the activity of insecticides on raspberry pests, see Table 4-17. *Activity of Insecticides on Raspberry Pests and Bees*, page 113.

Table 4-16. Activity of Fungicides on Raspberry Diseases

Use fungicides only for diseases listed on the product label for the crop and for the disease. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide group	Product	Anthraco- nose (elision)	Spur blight	Cane botrytis	Botrytis fruit rot	Raspberry leaf spot	Late leaf rust	Yellow rust	Powdery mildew	Phytophthora root rot	Crown gall	Fire blight
M	Ferbam 76 WDG	1*	1*	1	NA	—	1 ¹	1*	—	0	0	0
M	Lime Sulphur	1	1*	1	0	1	1 ¹ *	1*	—	0	0	0
M	Maestro 80 DF	2	2*	1	2*	1 to 2	0	—	—	0	0	0
M	Supra Captan 80 WDG	2	2*	1	2*	1 to 2	0	—	—	0	0	0
1	Senator 70 WP	2	2	1	0 to 1 R*	2	0	—	2*	0	0	0
2	Rovral WDG	—	—	1	2*	0	0	—	—	0	0	0
3	Jade	—	—	—	—	—	3	3*	3	—	—	—
3	Mission 418 EC	—	—	—	—	—	3	3*	3	—	—	—
3	Nova 40 W	—	—	—	—	—	3	3	3*	—	—	—
3	Topas	—	—	—	—	—	3	3*	3	—	—	—
4	Ridomil Gold 480 SL	0	0	0	0	0	0	—	0	3*	0	0
7	Cantus WDG	—	0	—	3*	—	0	—	—	0	0	0
7+11	Pristine WG	3	3	3	3*	3	3	—	3	0	0	0
9	Scala SC	—	—	—	3*	—	—	—	—	0	0	0
9+12	Switch 62.5 WG	—	—	3	3*	—	—	—	1	0	0	0
11+27	Tanos 50 DF	2*	2*	1*	1*	—	—	—	—	—	—	0
17	Elevate 50 WDG	—	1	3	3*	0	0	—	—	0	0	0
33	Aliette	0	0	0	0	0	0	—	0	2*	0	—
33	Phostrol	0	0	0	0	0	0	—	0	2*	0	—
44	Serenade MAX	—	—	—	1*	—	—	—	2	—	—	0
NC	Bloomtime Biological FD	0	0	0	0	0	0	0	0	0	0	1*

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations.

— = No information is available. * (shaded area) = Disease is listed on the product label for control or suppression. NA = Not used at the timing for this pest.

R = Resistance to this pathogen has occurred in some areas.

¹ Delayed dormant timing.

Table 4-17. Activity of Insecticides on Raspberry Pests and Bees

Use insecticides only for insects listed on the product label for the crop and for the insect.

The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide	Aphids	Raspberry sawfly	Raspberry fruitworm (beetle)	Leafrollers	Clipper weevil	Leafhoppers	Spider mites	Inchworms and loopers	Rose chafer	Raspberry cane borer	Raspberry crown borer (larvae)	Japanese beetle (adults)	Spotted wing drosophila (adult)	Bee toxicity
1A	Sevin XLR	2*	—	1	2*	—	2*	0	2	2	1	0	3*	1	HT
1B	Diazinon 50 WSP ¹	2*	3*	3*	2	1	1*	0	NA	NA	2	3*	NA	NA	HT
1B	Malathion 25 W	1	3	3*	2	2*	2*	0	2	2*	2	NA	2	2	HT
1B	Malathion 85 E	1	3	3	2	2*	2*	0	2	2	2	NA	2	2	HT
3	Pyganic 1.4 EC II	1*	—	—	—	—	1*	0	—	—	—	—	—	1	HT
4	Admire 240 F	3*	—	2	—	2	2*	0	—	2	2*	—	2	—	HT
4	Alias 240 SC	3*	—	2	—	2	2*	0	—	2	2*	—	2	—	HT
5	Delegate WG	—	—	—	3*	—	—	0	2	—	—	NA	—	3	HT
5	Entrust 80 W	—	—	—	3*	—	—	0	2*	—	—	NA	—	3	HT
5	Success	—	—	—	3*	—	—	0	2*	—	—	NA	—	3	HT
6	Agri-Mek 1.9% EC ²	0	0	0	0	0	—	3*	0	0	0	0	0	0	HT
10	Apollo SC	0	0	0	0	0	0	2*	0	0	0	0	0	0	S
11	Bioprotec CAF	0	0	0	2*	0	0	0	1	0	0	0	0	0	S
11	Dipel 2X DF	0	0	0	2*	0	0	0	1	0	0	0	0	0	S
11	Foray 48BA	0	0	0	2*	0	0	0	1	0	0	0	0	0	S
20B	Kanemite 15 SC	0	0	0	0	0	0	3*	0	0	0	0	0	0	S
21	Nexter ²	0	0	0	0	0	0	3*	0	0	0	0	0	0	HT
28	Altacor	0	—	—	3	—	—	0	3	—	—	2*	1	—	S
NC	Surround WP	1	—	—	—	—	2*	1	—	—	—	0	—	—	I
UN	Acramite 50 WS	0	0	0	0	0	0	3*	0	0	0	0	0	0	MT

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations.

Bee toxicity: HT = highly toxic. MT = Moderately toxic. S = Relatively safe or non-toxic. I = Irritant.

NA = Not used at the timing for this pest. — = No information is available. * (shaded area) = Pest is listed on the product label for control or suppression.

¹ Prebloom only.

² Postharvest only.

Saskatoon Berry Calendar

Read the product label and follow all safety precautions.

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-18. *Products Used on Saskatoon Berries*, page 117.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to berries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Early bud break			
Saskatoon bud moth Fruit tree leafroller	• Superior 70 Oil (<i>NC</i>)	20 L/1,000 L water	Ensure thorough coverage. Do not apply in freezing weather or if frost is expected.
Flower bud break			
Obliquebanded leafroller	• Success (5) or Entrust 80 W (5)	145–182 mL/ha 80–109 g/ha	Not all products are labelled for all pests. Choose a product based on which type of spring-feeding caterpillar is predominant. Success, Entrust, Intrepid: Use for obliquebanded leafroller and spanworm. Dipel, Bioprotec: Use for most leafrollers. Spray when larvae are very small and repeat at 3–7-day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See <i>Using Organic and Biopesticide Products</i> , page 242. Altacor, Exirel: Use for leafrollers. Do not tank-mix or make sequential applications of Exirel with Pristine.
Winter moth	• Dipel 2X DF (11) or Bioprotec CAF (11)	525–1,125 g/ha 1.4–2.8 L/ha	
Fruit tree leafroller	• Intrepid 240 F (18)	0.5 L/ha	
Spanworm	• Altacor (28) • Exirel (28)	215–285 g/ha 0.5–1.0 L/ha	
Saskatoon-juniper rust	• Funginex DC (3) • Pristine WG (7+11)	3 L/ha 1.6 kg/ha	This disease causes yellow spots and swellings on leaves and fruit. Infections on juniper spread up to 2 km to saskatoons. Prune out rust galls on juniper or remove entire juniper plants to reduce disease pressure. Spray before symptoms develop. Funginex: Apply once between flower bud break and white tip.

Disease or Insect	Product (Group)	Rate	Comments
Entomosporium leaf and berry spot	• Kumulus DF (M) or Microthiol Disperss (M)	7.5 kg/ha	Angular brown spots develop first on lower leaves, causing yellowing, defoliation and fruit cracking. Spray before symptoms develop. Apply at flower bud break and re-apply at 10–14-day intervals while disease risk persists. Kumulus, Microthiol Disperss: Do not apply if temperatures are over 27°C or leaf injury may result. Funginex: Apply once between flower bud break and white tip. Switch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	• Funginex DC (3)	3 L/ha	
	• Pristine WG (7+11)	1.6 kg/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
White tip			
Saskatoon-juniper rust	• Topas (3) or Jade (3) or Mission 418 EC (3)	500 mL/ha 500 mL/ha 300 mL/ha	This disease causes yellow spots and swellings on leaves and fruit. Infections on juniper spread up to 2 km to saskatoons. Prune out rust galls on juniper or remove entire juniper plants to reduce disease pressure. Spray before symptoms develop.
	• Pristine WG (7+11)	1.6 kg/ha	
Entomosporium leaf and berry spot	• Kumulus DF (M) or Microthiol Disperss (M)	7.5 kg/ha	Repeat at 10–14-day intervals while disease risk persists. Kumulus, Microthiol Disperss: Do not apply if temperatures are over 27°C or leaf injury may result. Switch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
		7.5 kg/ha	
	• Topas (3) or Jade (3) or Mission 418 EC (3)	500 mL/ha 500 mL/ha 300 mL/ha	
	• Pristine WG (7+11)	1.6 kg/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
Bloom			
Powdery mildew	• Nova 40 W (3)	113 g/1,000 L water or 340 g/ha	Apply before disease symptoms develop. Re-apply 10 days later, if needed. This product is in the same fungicide group as Topas, Jade, Mission and Funginex. Alternate with products from other groups for entomosporium leaf and berry spot control.
Fire blight	• Bloomtime Biological FD (NC)	375–500 g/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15–20% bloom, and second application at full bloom to petal fall. Refer to label for specific handling and storage requirements. See <i>Using Organic and Biopesticide Products</i> , page 242.
Petal fall			
Saskatoon-juniper rust	Use one of the products listed for saskatoon-juniper rust at White tip .		
Entomosporium leaf and berry spot	Use one of the products listed for entomosporium leaf and berry spot at White tip .		
Green fruit			
Powdery mildew	Use one of the products listed for powdery mildew at Bloom .		
Saskatoon-juniper rust	Use one of the products listed for saskatoon-juniper rust at White tip .		
Entomosporium leaf and berry spot	Use one of the products listed for entomosporium at White tip .		

Disease or Insect	Product (Group)	Rate	Comments
Obliquebanded leafroller	• Altacor (28) • Exirel (28)	215–285 g/ha 0.5–1.0 L/ha	Apply when eggs are hatching or young larvae are present. Use pheromone traps and spray at peak trap catch.
Japanese beetle	• Admire 240 F (4) • Altacor (28) • Exirel (28)	350 mL/ha 215–285 g/ha 1.5 L/ha	Admire: Do not make a foliar application following soil application of a Group 4 insecticide. Do not apply from bud stage to bloom or when bees are actively foraging. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with Pristine.
After harvest			
Woolly elm aphid Woolly apple aphid	• Orthene 75 % SP (1) • Admire 240 F (4) or Alias 240 SC (4)	For each plant: 1.7 g For each plant: 0.125 mL	These aphids feed on plant roots and reduce plant vigour. After harvest, dig up suspect bushes and examine the root systems for waxy white aphid colonies. Young plantings are especially susceptible. Make 1 application in mid-July to mid-August, after harvest is complete. Orthene: Application is by soil injection. Mix 0.85 g of Orthene in 1 L of water and apply 2 L per plant. Inject in 3–5 injection points about 12 inches deep. See product label for special application instructions. Admire, Alias: Apply in 200 L water/ha to the soil at the base of each plant, followed by sufficient water to move the product to the root zone. Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
White grubs	• Admire 240 (4)	1.2 L/ha	For reduction in numbers of larvae of European chafer and Japanese beetle. Apply to soil with sufficient water volume to move the product to the root zone. Use prior to egg hatch (shortly after adults are active) to control young larvae.
Special sprays (These pests are not a common problem on saskatoons. Spray if and when monitoring indicates the need.)			
Spotted wing drosophila	• Exirel (28)	1–1.5 L/ha	Although Exirel is the first full registration for SWD, additional products will be registered shortly. See www.ontario.ca/spottedwing for emergency uses and new product registrations. Alternate products from different groups. Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into saskatoon fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Check the www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.
Aphids	• Assail 70 WP (4) • Admire 240 F (4) • Movento 240 SC (23)	56–86 g/ha 175 mL/ha 220–365 mL/ha	Aphids are not normally a problem in saskatoon berries. Apply when aphid populations are high, but not during bloom, due to bee toxicity. This spray does not control root-feeding woolly elm or apple aphids.
Leafhoppers	• Admire 240 F (4)	175 mL/ha	Admire: Do not make a foliar application following soil application of a Group 4 insecticide. Do not apply from bud stage to bloom or when bees are actively foraging. Movento: Apply postbloom only.
Brown marmorated stink bug	• Actara 25 WG (4)	280 g/ha	At time of printing this publication, this pest has not been detected in berry crops, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Actara: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.

Table 4-18. Products Used on Saskatoon Berries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)
Products used to control or suppress insects and mites						
Actara 25 WG	28408	thiamethoxam	4	3 days	12 hours	2
Admire 240 F	24094	imidacloprid	4	3 days ¹ /14 days ²	24 hours	1 ² /2 ¹
Alias 240 SC	28475	imidacloprid	4	14 days	24 hours	1
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours ³ / 48 hours ⁴	4
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	4 hours	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust 80 W	27825	spinosad	5	3 days	when dry	3
Intrepid 240 F	27786	methoxyfenozide	18	7 days	12 hours	4 (max. 2 L/ha)
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.83 L/ha
Orthene 75% SP	14225	acephate	1B	11 months	72 hours	1
Success	26835	spinosad	5	3 days	when dry	3
Superior 70 Oil	9542	mineral oil	NC	¼-inch green	12 hours	1
Products used to control or suppress diseases						
Bloomtime Biological FD	28436	<i>Pantoea agglomerans</i>	NC	0 days	4 hours	2
Funginex DC	27686	triforine	3	60 days	48 hours	1
Jade	24030	propiconazole	3	38 days	12 hours	3
Kumulus DF	18836	sulphur	M	1 day	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	38 days	12 hours	3
Nova 40 W	22399	myclobutanil	3	14 days	when dry	3
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	when dry ³ / 29 days ⁴	4
Switch 62.5 WG	28189	cyprodinil and fludioxonil	9+12	1 day	12 hours ³ / 10 days ^{4,5}	3
Topas	30163	propiconazole	3	38 days	12 hours	3

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. — = Information is not specified on the product label.

¹ Foliar application.

² Soil application.

³ General re-entry.

⁴ Hand pruning and thinning.

⁵ Hand harvest.

Sea Buckthorn

Sea buckthorn has few insect and disease pests. However, as a part of the bushberry crop group, products registered for bushberries can be used on sea buckthorn (Table 4-19, *Pest Management Products for Sea Buckthorn*, page 118).

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to berries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Monitor sea buckthorn for pests and diseases, such as aphids, leafhoppers and mites, as well as the pests listed below.

Read the product label and follow all safety precautions.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Table 4-19. Pest Management Products for Sea Buckthorn

Pest	Common name	Product (Group)	Rate	Preharvest interval	Minimum re-entry	Max. number applications per season	Comments
Leafrollers and spanworms	spinosad	Success (5) or Entrust 80 W (5)	145–182 mL/ha 80–109 g/ha	3 days	when dry	3	Use pheromone traps to monitor. Spray at peak trap catch, or when very small larvae are present.
	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Dipel 2X DF (11)	525–1,125 g/ha	1 day	4 hours	—	Not all products are registered for both leafrollers and spanworms.
	methoxyfenozide	Intrepid 240 F (18)	0.5 L/ha	7 days	12 hours	4 (max. 2 L/ha)	Success, Entrust: Use for obliquebanded leafroller, spanworm or winter moth.
	chlorantraniliprole	Altacor (28)	285 g/ha	1 day	12 hours	3 (max. 6.45 g/ha)	Dipel: Use for leafrollers.
	cyantraniliprole	Exirel (28)	0.5–1.0 L/ha	3 days	12 hours	3	Intrepid: Use for obliquebanded leafroller, or spanworm. Altacor: Use for obliquebanded leafroller and spanworm. Exirel: Use for leafrollers.
Aphids	acetamiprid	Assail 70 WP (4)	56–86 g/ha	7 days	12 hours ¹ / 48 hours ²	4	—
	spirotetramat	Movento 240 SC (23)	220–365 mL/ha	7 days	12 hours	max. 1.83 L/ha	Use postbloom only.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand pruning and thinning.

Table 4-19. Pest Management Products for Sea Buckthorn (cont'd)

Pest	Common name	Product (Group)	Rate	Preharvest Interval	Minimum re-entry	Max. number applications per season	Comments
Gypsy moth	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Bioprotec CAF (11)	2.4–4 L/ha	0 days	12 hours	—	Apply when larvae are young, before damage is evident, and at times when larvae are actively feeding on treated surfaces. Repeat at 7–10-day intervals, as needed. See <i>Using Organic and Biopesticide Products</i> , page 242.
Japanese beetle	chlorantraniliprole	Altacor (28)	285 g/ha	1 day	12 hours	3 (max. 6.45 g/ha)	When monitoring indicates the need. Altacor: Suppression only, see Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	cyantraniliprole	Exirel (28)	1.5 L/ha	3 days	12 hours	4	
Weevils	thiamethoxam	Actara 25 WG (4)	210–280 g/ha	3 days	12 hours	2	Apply to foliage to control adult weevils. Do not apply during bloom or when bees are active.
Brown marmorated stink bug	thiamethoxam	Actara 25 WG (4)	280 g/ha	3 days	12 hours	2	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. At time of printing this publication, this pest has not been detected in crops, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for information. Do not apply during bloom or when bees are active.
Spotted wing drosophila	cyantraniliprole	Exirel (28)	1.0–1.5 L/ha	3 days	12 hours	4	Although Exirel is the first full registration for SWD, additional products will be registered shortly. See www.ontario.ca/spottedwing for emergency uses and new product registrations. Alternate products from different groups. Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Check www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.
Brown rot	sulphur	Microscopic Sulphur (M)	6.5 kg/1,000 L water/ha	7 days	24 hours	8	For orchards with a history of brown rot, apply at the beginning of bloom if weather conditions are conducive to disease development (e.g., warm, wet conditions). Repeat at 7–10-day intervals as needed.
Botrytis	<i>Bacillus subtilis</i>	Serenade MAX (44)	3–6 kg/ha	0 days	12 hours	—	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Bacterial blight			1–3 kg/ha	0 days	12 hours	—	
Leaf spot (<i>Septoria</i> sp.)	prothioconazole	Proline 480 SC (3)	315 mL/ha	7 days	24 hours	2	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

— = Information is not specified on the product label.

¹ General re-entry.² Hand pruning and thinning.

Non-bearing Strawberry Calendar (planting year)

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

The chemical group is indicated in brackets following the product name. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN). Use products from different groups to help prevent pest resistance. For resistance management refer to *Resistance Management Strategies*, page 257.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-20. *Products Used on Strawberries*, page 132.

Disease or Insect	Product (Group)	Rate	Comments
Before planting			
Red stele Root lesion nematode	• MustGrow (NC)	980–2,240 kg/ha	MustGrow is a pelleted formulation of oriental mustard seed meal. Apply with a calibrated spreader, in early spring when soil temperatures are above 10°C, but at least 2 weeks before planting. Incorporate into the upper soil layer to a depth of 10–15 cm, followed by irrigation to ensure the top 10–15 cm of soil are well-moistened. Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
At planting or up to 8 days after planting			
Black root rot	• Quadris (11)	1.1 L/ha or 6 mL/100 m of row	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply in the transplant furrow or as a high-volume application directed at the crown in 1,000–1,500 L/ha water. Mount the spray nozzle so the spray is directed over the plants as a 15–20-cm wide band. For drench application, use 10 L of water per 100 m and irrigate afterwards to ensure adequate movement of the product to the roots. Scholar : Also registered for application through drip irrigation systems. See label.
	• Scholar 230 SC (12)	1.2 L/ha or 6.5 mL/100 m of row	
May or early June (when new growth begins after transplanting)			
Aphids	• Cygon 480-AG (1) or Lagon 480 E (1)	2.25 L/ha 1 L/ha	Apply when growth begins after transplanting. Do not apply during bloom due to bee toxicity. Spray before buds open or after de-blossoming. Cygon, Lagon : Apply as a foliar spray. Admire (soil application) : Use 7.5–12 mL/100 m of row in 2,000 L/ha of water as a surface band directly to the plant row. Rate is approx. 850 mL–1.3 L/ha, but depends on row spacing. See label for conversions. Do not use both soil and foliar applications of Group 4 insecticides in the same year. Assail (foliar application) : Use a 7-day interval between sprays. Use high rate under heavy pest pressure. Admire, Assail : Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.
	• Admire 240 F (4)	0.85–1.3 L/ha	
	• Assail 70 WP (4)	56–86 g/ha	
Leafrollers	• Malathion 85 E (1)	975 mL/ha	Apply only if leafrollers are easy to find. Dipel, Bioprotec : Spray when larvae are small and repeat at 3–7-day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See <i>Using Organic and Biopesticide Products</i> , page 242.
	• Success (5) or Entrust 80 W (5)	145–182 mL/ha 80–109 g/ha	
	• Dipel 2X DF (11) or Bioprotec CAF (11)	525–1,125 g/ha 1.4–2.8L/ha	
	• Altacor (28)	215–285 g/ha	
Strawberry cutworm	• Warhawk 480 EC (1) or Pyrinex 480 EC (1)	1.2 L/ha 1.2 L/ha	Apply if cutworm activity is evident, usually June 1–June 15. Apply in 2,000 L water/ha. Do not confuse cutworm damage with deer browsing.
	• Altacor (28)	215–285 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
One month after planting and again once or twice at 2-week intervals			
Common leaf spot	- Copper 53 W (M) - Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Senator 70 WP (1) - Topas (3) or Jade (3) or Mission 418 EC (3) - Pristine WG (7+11)	3.8 kg/ha 4.25 kg/ha 4.25 kg/ha 1.1 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.3–1.6 kg/ha	Protect new leaves as they unfold. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar and MicMac. Copper: Use alone. For instructions on mixing copper sprays, see Table 9-2. <i>Copper Products Used on Fruit Crops</i> , page 254. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide.
Aphids	- Cygon 480-AG (1) or Lagon 480 E (1) - Admire 240 F (4) - Assail 70 WP (4)	2.25 L/ha 1 L/ha 175 mL/ha 56–86 g/ha	Continue to monitor for aphids and protect new plants when aphids are present. Remove all bloom and blossom clusters before application, and apply as a foliar spray. Do not apply when bees are actively foraging. Do not use both soil and foliar applications of Group 4 insecticides in the same year.
July to mid-August			
Potato leafhopper	- Malathion 85 E (1) - Assail 70 WP (4) - Admire 240 F (4) - Surround WP (NC)	975 mL/ha 56–86 g/ha 175 mL/ha 25 kg/ha	Potato leafhoppers migrate long distances and often appear when nearby hay fields are mowed. Check under side of leaves and spray when nymphs are present. Repeated applications may be necessary. Admire, Assail: Highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements. Remove all bloom and blossom clusters before application, and apply as a foliar spray. Do not use both soil and foliar applications of Group 4 insecticides in the same year. Surround: Apply at 7–14-day intervals when leafhoppers are first detected by monitoring. For early applications, use 25 kg/ha per 500 L of water. Once a base coat is established, use 12.5 kg/ha per 500 L of water for subsequent sprays. Do not apply during bloom or when fruit is present. See <i>Using Organic and Biopesticide Products</i> , page 242.
Aphids	Use one of the products listed for aphids at One month after transplanting .		
Powdery mildew	- Mettle 125 ME (3) - Nova 40 W (3) - Pristine WG (7+11) - Flint (11) - Quintec (13) - Actinovate SP (NC) - Tivano (NC) - Regalia Maxx (P5)	219–365 mL/ha 340 g/ha 1.6 kg/ha 140 g/ha 300–440 mL/ha 425 g/ha 16–24 L/ha 0.125–0.25% w/v in 500–1,000 L water per ha	Begin applications when conditions favour disease or before the first signs of mildew on foliage. Continue as needed on a 7–14-day interval. Use the shorter spray interval when pressure is severe. Actinovate, Tivano, Regalia Maxx: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> page 242. Tivano: Use in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. Regalia Maxx: Use 0.125% (1.25 L in 1,000 L water) in a tank-mix with other powdery mildew fungicides or 0.25% (2.5 L in 1,000 L water) in rotation with other powdery mildew fungicides.
White grubs	Admire 240 F (4)	1.2 L/ha	Reduction in numbers of European chafer and Japanese beetle larvae. Apply just prior to egg hatch (shortly after adults are active) to control young larvae. Apply to soil, before mulch is applied. Do not use both soil and foliar applications of Group 4 insecticides in the same year. Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.
Black root rot	Scholar 230 SC (12)	1.2 L/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply as a high-volume application directed at the crown in sufficient water to ensure even coverage (1,000–1,500 L/ha). Mount the spray nozzle so the spray is directed over the plants as a 15–20-cm wide band. For drench application, use 10 L of water per 100 m and irrigate afterwards to ensure adequate movement to the roots.
Common leaf spot	If leaf spot is present, continue fungicide applications at regular intervals, prior to wetting periods. Use one of the products listed for common leaf spot at One month after planting .		

Disease or Insect	Product (Group)	Rate	Comments
Mid-August and again once or twice at 2-week intervals			
Powdery mildew	Use one of the products listed for powdery mildew at July to mid-August .		
Common leaf spot	This is an important timing for control. If leaf spot is present, or on susceptible varieties, continue fungicide applications at regular intervals, prior to wetting periods. Use one of the products listed for common leaf spot at One month after planting .		
Fall			
Red stele	• Ridomil Gold 480 SL (4) • Aliette (33)	1 L/ha 5.6 kg/ha	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 4-24, <i>Strawberry Variety Disease Ratings</i>, page 137). To reduce the chance of resistance, spray only where red stele has been observed or a high-risk situation occurs. Ridomil Gold: Make 1 application in early September and a second treatment in late October, no later than October 31. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. Aliette: Maximum of 4 applications per season: 2 in spring and 2 in fall. Apply as a foliar spray in spring when plants start active growth. Apply at 30–60-day intervals. Make fall applications when soil conditions favour disease development (e.g., high soil moisture, cool temperatures).

June-bearing Strawberry Calendar (fruiting years)

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

For preharvest interval, re-entry period, and maximum number of applications, see Table 4-20. *Products Used on Strawberries*, page 132.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to strawberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
When new growth appears			
Strawberry aphid	• Cygon 480-AG (1) or Lagon 480 E (1) • Admire 240 F (4) or Alias 240 SC (4) • Assail 70 WP (4)	2.25 L/ha 1 L/ha 850 mL–1.3 L/ha 850 mL–1.3 L/ha 56–86 g/ha	Apply when growth begins in the spring. Do not apply when bloom is present due to bee toxicity. Cygon, Lagon: Apply as a foliar spray. Admire, Alias: Apply as a soil drench with sufficient water to ensure incorporation into the root zone. Admire: Use 7.5–12 mL/100 m of row in 2,000 L/ha of water as a surface band directly to the plant row. Rate is approx. 850 mL–1.3 L/ha, but depends on row spacing. See label for conversions. Assail: Apply as a foliar spray. Use a 7-day interval between sprays. Under heavy pressure, use the high rate. Admire, Alias, Assail: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Refer to label for specific bee toxicity statements. Do not use both soil and foliar applications of Group 4 insecticides in the same year.
Red stele	• Aliette (33)	5.6 kg/ha	This disease is sporadic and favoured by wet or compacted soil and susceptible varieties (Table 4-24. <i>Strawberry Variety Disease Ratings</i> , page 137). Spray only where red stele has been observed or a high-risk situation occurs. Aliette: Maximum 4 applications per season: 2 in spring and 2 in fall. Apply in spring when plants start active growth. Apply at 30–60-day intervals. Do not apply within 30 days of harvest or after first bloom.
Botrytis grey mould	• Bravo 500 (M) or Echo 720 (M)	3.5 L/ha 2.4 L/ha	Bravo, Echo: Reduces disease inoculum and prevents infection of senescent leaves. Re-apply 10 days later.

Disease or Insect	Product (Group)	Rate	Comments
Black root rot	• Scholar 230 SC (12)	1.2 L/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply as a high-volume application directed at the crown in sufficient water to ensure even coverage (1,000–1,500 L/ha). Mount the spray nozzle so the spray is directed over the plants as a 15–20-cm wide band. For drench application, use 10 L of water per 100 m and irrigate afterwards to ensure adequate movement of the product to the roots.
When flower buds are visible in the crown			
Cyclamen mite	• Thionex 50 WSP (2) • Agri-Mek 1.9% EC (6)	4.0 kg/ha 1 L/ha	Apply where cyclamen mite has been a problem in the past. These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. Thionex: Apply in 4,000 L of water/ha as a drench over the plant row. Agri-Mek: Apply in sufficient water, to ensure thorough leaf coverage.
Common leaf spot	• Copper 53 W (M) • Supra Captain 80 WDG (M) or Maestro 80 DF (M) • Senator 70 WP (1) • Topas (3) or Jade (3) or Mission 418 EC (3) • Pristine WG (7+11)	3.8 kg/ha 4.25 kg/ha 4.25 kg/ha 1.1 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.3–1.6 kg/ha	Protect new leaves as they unfold. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar and MicMac. Copper: Apply alone in 1,000 L water/ha. See Table 9-2. <i>Copper Products Used on Fruit Crops</i> , page 254. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide.
Angular leaf spot	• Tivano (NC)	16–24 L/ha	Tivano: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Mix in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. See <i>Using Organic and Biopesticide Products</i> , page 242.
As flower buds extend from crown			
Strawberry clipper weevil	• Ripcord (3) or Up-Cyde 2.5 EC (3) • Matador 120 EC (3) or Silencer 120 EC (3)	175 mL/ha 280 mL/ha 104 mL/ha 104 mL/ha	Check edges of fields for clipped buds. Spray when first injury is detected, or wait until threshold is reached (approximately 13 clipped buds per m of row). Re-apply if new injury is detected 7 days later.
Tarnished plant bug (adults)	• Cygon 480-AG (1) • Clutch 50 WDG (4)	2.75 L/ha 448 g/ha	These products are very toxic to bees. Do not use during bloom or when bees are active.
First bloom			
INSECTICIDES MAY BE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE ACTIVE. SPRAY IN THE EVENING. SEE BEE POISONING, PAGE 269.			
Tarnished plant bugs	• Thionex 50 WSP (2) • Ripcord (3) or Up-Cyde 2.5 EC (3) • Decis 5 EC (3) • Matador 120 EC (3) or Silencer 120 EC (3) • Rimon 10 EC (15)	2.0 kg/ha 250 mL/ha 400 mL/ha 200 mL/ha 104 mL/ha 104 mL/ha 835 mL/ha	Do not spray when bees are active. Refer to label for specific bee toxicity statements. During bloom and green fruit stage, shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see www.ontario.ca/cropipgm . Ripcord, Up-Cyde, Decis, Matador, Silencer: These products also control spittlebug and, except Decis, clipper weevil. These products may lead to mite outbreaks. Rimon: Apply when nymphs are still in early instar stages. Re-apply 10–14 days later.

Disease or Insect	Product (Group)	Rate	Comments
Botrytis grey mould	• Supra Captan 80 WDG (M)	4.25 kg/ha	Ensure good spray coverage to keep all flower parts protected with fungicide during bloom. Typically 2–3 sprays at 7–10-day intervals during bloom will give good control. Use shorter spray intervals (i.e., 5–7 days) during wet weather. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide. Granuflo-T, Thiram: Use up to 2,000 L water per ha. Serenade MAX, Actinovate: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. For best results, use multiple applications or in rotation with other products. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• or Maestro 80 DF (M)	4.25 kg/ha	
	• Folpan 80 WDG (M)	2.5 kg/ha	
	• Granuflo-T (M)	2.25–2.5 kg/1,000 L water	
	• or Thiram 75 WP (M)	2.25–2.5 kg/1,000 L water	
	• Senator 70 WP (1)	1.1 kg/ha	
	• Rovral WDG (2)	2 kg/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
	• Cantus WDG (7)	560 g/ha	
	• Pristine WG (7+11)	1.3–1.6 kg/ha	
	• Scala SC (9)	2 L/ha	
	• Switch 62.5 WG (9+12)	975 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	
Anthracnose fruit rot	• Cabrio EG (11)	1 kg/ha	Bloom is the best time to control this disease. Warm wet weather during bloom favours the development of anthracnose fruit rot. Actinovate: May reduce symptoms but does not provide control or suppression of anthracnose. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Pristine WG (7+11)	1.3–1.6 kg/ha	
	• Actinovate SP (NC)	425 g/ha	
Leather rot	• Phostrol (33)	4.1 L/ha	Begin applications at 10% bloom and continue at 7-day intervals if conditions favour disease (heavy rains, standing water, rain-splashed soil, history of damage). Confine Extra: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
	• Confine Extra (33)	4–5 L/ha	

7 to 10 days after first bloom

Botrytis grey mould	Use one of the products listed for botrytis at First bloom .		
Anthracnose fruit rot	Use one of the products listed for anthracnose at First bloom .		
Tarnished plant bugs	This is a critical time for control. Continue to monitor for tarnished plant bug. If thresholds are reached, use one of the products listed for tarnished plant bug at First bloom .		
Thrips	• Delegate WG (5)	280 g/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Check blossoms and under calyces for small thread-like yellow thrips. Expect more problems where insecticides have not been applied for tarnished plant bug. If populations are high, re-apply in 3–4 days. This product is toxic to bees exposed to direct treatment, drift or residues on blooming plants. Do not apply during bloom or when bees are active.

Green fruit

Leather rot (suppression)	Use one of the products listed for leather rot at First bloom if conditions are favourable for infection.		
Tarnished plant bugs	• Thionex 50 WSP (2) • Ripcord (3) • or Up-Cyde 2.5 EC (3) • Decis 5 EC (3) • Matador 120 EC (3) • or Silencer 120 EC (3) • Assail 70 WP (4) • Rimon 10 EC (15)	2.0 kg/ha 250 mL/ha 400 mL/ha 200 mL/ha 104 mL/ha 104 mL/ha 84–210 g/ha 835 mL/ha	This is the best timing for Rimon and Assail. Do not spray when bees are active. During bloom and green fruit stage, shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see www.ontario.ca/cropipm. Ripcord, Up-Cyde, Decis, Matador, Silencer: These products also control spittlebug and, except Decis, clipper weevil. These products may lead to mite outbreaks. Assail: Use a 7-day interval between sprays. Under heavy pressure, use the high rate. Rimon: Apply when nymphs are still in the early instar stages. Re-apply 10–14 days later.

Disease or Insect	Product (Group)	Rate	Comments
Two-spotted spider mite	• Agri-Mek 1.9% EC (6)	1 L/ha	Use high water volumes to ensure good coverage of the underside of leaves. See Table 4-22. <i>Miticides Registered on Strawberries</i> , page 135, for details on timing. Agri-Mek, Nexter: Do not spray when bees are active.
	• Apollo SC (10)	500 mL/ha	
	• Nexter (21)	600 g/ha	
	• Oberon (23)	880 mL/ha	
Preharvest			
Botrytis grey mould	Use one of the products listed for botrytis at First bloom . If sprinkler irrigation is used, water early in the day to allow plants to dry off before nightfall.		
Anthraxnose fruit rot	Warm wet weather favours development of anthracnose. In these conditions, use one of the products listed for anthracnose at First bloom .		
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into strawberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check www.ontario.ca/spottdwing for updates on pest development, registered products and management strategies for control.		
Slugs	• Sluggo Professional (NC)	25 kg/ha	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed or at least every 2 weeks if slugs and snails continue to be a problem.
Renovation (after mowing to July)			
Cyclamen mite	• Thionex 50 WSP (2)	4 kg/ha	These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. High water volumes are needed to contact the new growth in the crown. Thionex: Apply in 4,000 L of water/ha as a drench over the plant row.
Black vine weevil adults	• Matador 120 EC (3)	104 mL/ha	Actara: Apply to foliage when adults are present, usually during and after harvest. Do not apply if a soil application of a Group 4 insecticide was applied. Also controls cranberry weevils. Highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements. Matador, Silencer: Suppression only. Apply when adults begin to be present, but not until after harvest. May be less effective at high temperatures (over 27°C).
	or Silencer 120 EC (3)	104 mL/ha	
	• Actara 25 WG (4)	210–280 g/ha	
Black root rot	• Scholar 230 SC (12)	1.2 L/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply as a high-volume application directed at the crown in sufficient water to ensure even coverage (1,000–1,500 L/ha). Mount the spray nozzle so the spray is directed over the plants as a 15–20-cm wide band. For drench application, use 10 L of water per 100 m and irrigate afterwards to ensure adequate movement of the product to the roots.
New growth after renovation (late July to early August)			
Aphids	• Cygon 480-AG (1)	2.25 L/ha	Apply to foliage. Admire, Assail: Also control leafhoppers. Do not make a foliar application following a soil application of a Group 4 insecticide. Highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.
	or Lagon 480 E (1)	1 L/ha	
	• Admire 240 F (4)	175 mL/ha	
	• Assail 70 WP (4)	56–86 g/ha	
Two-spotted spider mite	• Agri-Mek 1.9% EC (6)	1 L/ha	See Table 4-22. <i>Miticides Registered on Strawberries</i> , page 135, for details on timing. Use high water volumes to ensure good coverage of the underside of leaves.
	• Nexter (21)	600 g/ha	
	• Oberon (23)	880 mL/ha	

Disease or Insect	Product (Group)	Rate	Comments	
Powdery mildew	• Mettle 125 ME (3) • Nova 40 W (3) • Flint (11) • Pristine WG (7+11) • Quintec (13) • Actinovate SP (NC) • Tivano (NC) • Regalia Maxx (PS)	219–365 mL/ha 340 g/ha 140 g/ha 1.6 kg/ha 300–440 mL/ha 425 g/ha 16–24 L/ha 0.125–0.25% v/v in 500–1,000 L water/ha	Begin applications when conditions favour disease or before the first signs of mildew on foliage. Continue as needed on a 7–14-day interval. Use the shorter spray interval when pressure is severe. Actinovate, Tivano, Regalia Maxx: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. Tivano: Use in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. Regalia Maxx: Use 0.125% (1.25 L in 1,000 L water) in a tank-mix with other powdery mildew fungicides or 0.25% (2.5 L in 1,000 L water) in rotation with other powdery mildew fungicides.	
White grubs	• Admire 240 F (4)	1.2 L/ha	For reduction in numbers of larvae of European chafer and Japanese beetle. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Apply to soil, before mulch is applied. Apply just prior to egg hatch (shortly after adults are active) to control young larvae. Do not use both soil and foliar applications of Group 4 insecticides in the same year. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Refer to label for specific bee toxicity statements.	
Mid-August and again once or twice at 2-week intervals				
Powdery mildew	Use one of the fungicides for powdery mildew at New growth after renovation .			
Angular leaf spot	• Tivano (NC)	16–24 L/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Mix in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. See <i>Using Organic and Biopesticide Products</i>, page 242.	
Common leaf spot	• Copper 53 W (M) • Supra Captan 80 WDG (M) or Maestro 80 DF (M) • Senator 70 WP (1) • Topas (3) or Jade (3) or Mission 418 EC (3) • Pristine WG (7+11)	3.8 kg/ha 4.25 kg/ha 4.25 kg/ha 1.1 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.3–1.6 kg/ha	Ensure thorough coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, and MicMac. Copper: Best if used alone. See Table 9-2. <i>Copper Products Used on Fruit Crops</i>, page 254. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide.	
	Fall			
	Botrytis grey mould	• Bravo 500 (M) or Echo 720 (M)	3.5 L/ha 2.4 L/ha	Bravo, Echo: Control this disease by reducing inoculum. Apply in late October.
	Red stele	• Ridomil Gold 480 SL (4) • Aliette (33)	1 L/ha 5.6 kg/ha	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 4-24. <i>Strawberry Variety Disease Ratings</i>, page 137). Spray only where red stele has been observed or a high-risk situation occurs. Ridomil: Do not apply later than October 31. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. Aliette: Maximum of 4 applications per season: 2 in spring and 2 in fall. Apply in spring when plants start active growth. Apply at 30–60-day intervals. Make postharvest applications when soil conditions favour disease development (e.g., high soil moisture and cool soil temperatures).

Day-neutral Strawberry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

For preharvest intervals, re-entry period, and maximum number of applications, see Table 4-20, *Products Used on Strawberries*, page 132.

Resistance Management

To delay development of resistance to fungicides, insecticides and miticides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. Use products from different groups to help prevent resistance. The chemical group is indicated in brackets following the product name. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to strawberries during bloom – do not apply them while bees are active. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
New growth (early spring)			
Aphids	• Cygon 480-AG (1)	2.25 L/ha	Apply when growth begins in the spring. Do not apply when bloom is present due to bee toxicity. Refer to label for specific bee toxicity statements. Cygon, Lagon: Apply as a foliar spray. Admire, Alias: Apply as a soil drench with sufficient water to ensure incorporation into the root zone. Admire: Use 7.5–12 mL/100 m of row in 2,000 L/ha of water as a surface band directly to the plant row. Rate is approx. 850 mL–1.3 L/ha, but depends on row spacing. See label for conversions. Assail: Apply as a foliar spray. Use a 7-day interval between sprays. Under heavy pressure, use the high rate. Do not use both soil and foliar applications of Group 4 insecticides in the same year. Admire, Alias, Assail: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Read the specific bee toxicity statements on the label.
	or Lagon 480 E (1)	1 L/ha	
	• Admire 240 F (4)	850 mL–1.3 L/ha	
	or Alias 240 SC (4)	850 mL–1.3 L/ha	
	• Assail 70 WP (4)	56–86 g/ha	
Black root rot	• Scholar 230 SC (12)	1.2 L/ha	Suppression only. See Table 11-1, <i>Pesticide Efficacy Ratings</i>, page 267. For plasticulture systems, apply through drip irrigation system. See label for details and rates. In matted row plantings, direct application at the crown in sufficient water to ensure even coverage (1,000–1,500 L/ha). Mount the spray nozzle so the spray is directed over the plants as a 15–20-cm wide band. For drench application, use 10 L of water per 100 m and irrigate afterwards to ensure adequate movement of the product to the roots.
When flower buds extend from the crown – late April, early May (established plantings planted previous year)			
Strawberry clipper weevil	• Ripcord (3)	175 mL/ha	Strawberry clipper weevil is rarely a problem in first-year plantings. Check for clipped buds in overwintered plantings, especially near woods, bush, or under floating row covers. Apply an insecticide when the threshold is reached. For thresholds and monitoring details, see www.ontario.ca/cropipm.
	or Up-Cyde 2.5 EC (3)	280 mL/ha	
	• Matador 120 EC (3)	104 mL/ha	
	or Silencer 120 EC (3)	104 mL/ha	

Disease or Insect	Product (Group)	Rate	Comments
Two-spotted spider mite	• Agri-Mek 1.9 % EC (6)	1 L/ha	Occasionally two-spotted spider mites are a problem early in the season, especially where row covers are used. Overwintering TSSM are bright orange. Do not spray for this stage. Wait for this generation to lay eggs. Good spray coverage of both upper and lower leaf surfaces is needed for control. Use adequate water volume for complete coverage. See Table 4-22. <i>Miticides Registered on Strawberries</i> , page 135, for details on timing.
	• Apollo SC (10)	500 mL/ha	
	• Oberon (23)	880 mL/ha	
Tarnished plant bug (adults)	• Cygon 480-AG (1)	2.75 L/ha	Both products are very toxic to bees. Do not apply during bloom or when bees are active.
	• Clutch 50 WDG (4)	448 g/ha	

Bloom

INSECTICIDES MAY BE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE ACTIVE. SPRAY IN THE EVENING. SEE BEE POISONING, PAGE 269.

Tarnished plant bugs	• Thionex 50 WSP (2)	2.0 kg/ha	Do not spray when bees are active. Refer to label for specific bee toxicity statements. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see www.ontario.ca/croppgm. In established plantings that were overwintered, check as soon as row covers are removed (early May) and continue at weekly intervals when bloom and green fruit are present. In new plantings, remove blossom clusters until plants are well-established (6–8 new leaves). Subsequent bloom in new plantings typically coincides with the second generation of tarnished plant bug (early July). Pressure is high at this time and damage can occur quickly. Rimon, Assail: In order to meet restrictions limiting the number of applications, most growers will reserve the use of Rimon and Assail until closer to harvest. Ripcord, Up-Cyde, Decis, Matador, Silencer: These products, except Decis, also control clipper weevil. Products from this group may lead to mite or thrips outbreaks. Assail: Use a 7-day interval between sprays. Works best on small nymphs in early instars. Use the high rate under heavy pest pressure and older nymphs (3rd–5th instar). Rimon: Apply when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid applying this product to flowering crops or weeds if bees are visiting the treatment area.
	• Ripcord (3)	250 mL/ha	
	• or Up-Cyde 2.5 EC (3)	400 mL/ha	
	• Decis 5 EC (3)	200 mL/ha	
	• Matador 120 EC (3)	104 mL/ha	
	• or Silencer 120 EC (3)	104 mL/ha	
	• Assail 70 WP (4)	84–210 g/ha	
Botrytis grey mould	• Rimon 10 EC (15)	835 mL/ha	
	• Supra Captan 80 WDG (M)	4.25 kg/ha	Ensure good spray coverage to keep all flower parts protected with fungicide during bloom. Typically 7–10-day intervals during bloom will give good control. Use shorter spray intervals (i.e., 5–7 days) during wet weather. Senator: Resistance develops rapidly. Tank-mix with a compatible Group M fungicide. Granuflo-T, Thiram: Use up to 2,000 L water/ha. Serenade MAX: For best results, use multiple applications or in rotation with other products. Serenade MAX, Actinovate: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242.
	• or Maestro 80 DF (M)	4.25 kg/ha	
	• Folpan 80 WDG (M)	2.5 kg/ha	
	• Granuflo T (M)	2.25–2.5 kg/1,000 L water	
	• or Thiram 75 WP (M)	2.25–2.5 kg/1,000 L water	
	• Senator 70 WP (1)	1.1 kg/ha	
	• Rovral WDG (2)	2 kg/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
	• Pristine WG (7+11)	1.3–1.6 kg/ha	
	• Cantus WDG (11)	560 g/ha	
	• Scala SC (9)	2 L/ha	
	• Switch 62.5 WG (9+12)	975 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	
	• Serenade MAX (44)	3.0–6.0 kg/ha	
	• Actinovate SP (NC)	425 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Anthracnose fruit rot	• Cabrio EG (11) • Pristine WG (7+11) • Actinovate SP (NC)	1 kg/ha 1.3–1.6 kg/ha 425 g/ha	Warm wet weather during bloom favours disease development. Actinovate: May reduce symptoms but does not provide control or suppression of anthracnose.
Angular leaf spot	• Tivano (NC)	16–24 L/ha	Tivano: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Mix in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. See <i>Using Organic and Biopesticide Products</i> , page 242.
Powdery mildew	• Mettle 125 ME (3) • Nova 40 W (3) • Pristine WG (7+11) • Flint (11) • Quintec (13) • Actinovate SP (NC) • Tivano (NC) • Regalia Maxx (P5)	219–365 mL/ha 340 g/ha 1.6 kg/ha 140 g/ha 300–440 mL/ha 425 g/ha 16–24 L/ha 0.125–0.25% v/v in 500–1,000 L water	Begin applications when conditions favour disease or before the first signs of mildew on foliage. Continue as needed on a 7–14-day interval. Use the shorter spray interval when pressure is severe. Actinovate, Tivano, Regalia Maxx: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242. Tivano: Use in 200 L water/ha to obtain a 8–12% solution. Multiple applications at 7–10-day intervals are required for control. Regalia Maxx: Use 0.125% (1.25 L in 1,000 L water) in a tank-mix with other powdery mildew fungicides or 0.25% (2.5 L in 1,000 L water) in rotation with other powdery mildew fungicides.
Bloom and green fruit			
Two-spotted spider mite	• Agri-Mek 1.9% EC (6) • Apollo SC (10) • Nexter (21) • Oberon (23)	1 L/ha 500 mL/ha 600 mL/ha 880 g/ha	Use high water volumes to ensure good coverage of the underside of leaves. See Table 4-22. <i>Miticides Registered on Strawberries</i> , page 135, for details on timing. Agri-Mek, Nexter: Toxic to bees exposed to direct treatment, drift or residues on blooming plants.
Tarnished plant bug	Continue to monitor for tarnished plant bug. If thresholds are reached, choose an insecticide listed at Bloom for this pest, but check the preharvest interval. Late May and early July are periods of peak activity for tarnished plant bugs, but populations vary due to the use of row covers, crop management, weed species in the field, nearby alfalfa and clover crops, and insecticides applied for other pests. Weekly monitoring is important.		
Bloom, green fruit and harvest (June, July, August)			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into strawberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Populations build up in late summer, putting day-neutral strawberries at risk. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check www.ontario.ca/spottedwing for updates on pest development, registered products and management strategies for control.		
Tarnished plant bugs	• Assail 70 WP (4) • Rimon 10 EC (15)	84–210 g/ha 835 mL/ha	These products have short preharvest intervals and can be used during harvest. Do not apply during bloom or when bees are active. Refer to label for specific bee toxicity statements. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see www.ontario.ca/cropipm . Assail: Works best on small nymphs in early instars. Use the high rate under heavy pest pressure and older nymphs (3rd–5th instar). Rimon: Apply when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds.
Thrips	• Delegate WG (5)	280 g/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Check blossoms and under calyxes for small thread-like yellow thrips. This product is toxic to bees exposed to direct treatment, drift or residues on blooming plants.
Two-spotted spider mite	• Oberon (23)	880 mL/ha	Use high water volumes to ensure good coverage of the underside of leaves. See Table 4-22. <i>Miticides Registered on Strawberries</i> , page 137, for details on timing.

Disease or Insect	Product (Group)	Rate	Comments
Potato leafhopper	• Malathion 85 E (1)	975 mL/ha	Check leaf edges for yellowing and check the lower leaf surface for small, rapidly moving bright green nymphs. Potato leafhoppers have many hosts and often build up in strawberry fields after the first few cuts of local hay. Albion is especially susceptible to leafhoppers. Toxic to bees. Do not apply this product to flowering crops or weeds if bees are visiting the treatment area.
Angular leaf spot (suppression)	Use one of the products listed for angular leaf spot at Bloom .		
Botrytis grey mould	Use one of the products listed for botrytis at Bloom .		
Anthrachnose fruit rot	Use one of the products listed for anthracnose at Bloom .		
Powdery mildew	This is an important time for mildew control. Use one of the products listed for mildew at Bloom .		
Bloom, green fruit and harvest (September)			
Slugs	• Sluggo Professional (NC)	25 kg/ha	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed or at least every 2 weeks if slugs and snails continue to be a problem.
Tarnished plant bug	Continue to monitor for tarnished plant bug. If thresholds are reached in early September, use one of the products listed for tarnished plant bug at Bloom, green fruit and harvest (June, July, August) .		
Powdery mildew	This is an important time for mildew control. Use one of the products listed for mildew at Bloom .		
Botrytis grey mould	Use one of the products listed for botrytis at Bloom .		
Angular leaf spot	Use one of the products listed for angular leaf spot at Bloom .		

Table 4-20. Products Used on Strawberries

Use this as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects and mites.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used to control or suppress insects and mites						
Actara 25 WG	28408	thiamethoxam	4	3 days	12 hours	2
Admire 240 F	24094	imidacloprid	4	7 days ¹ /30 days ²	24 hours	2 ¹ /1 ²
Agri-Mek 1.9% EC	24551	abamectin	6	3 days	12 hours	2
Alias 240 SC	28475	imidacloprid	4	30 days	24 hours	1 ²
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3
Apollo SC	21035	clofentezine	10	15 days	12 hours	1
Assail 70 WP	27128	acetamiprid	4	1 day	12 hours	2
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	4 hours	—
Clutch 50 WDG	29382	clothianidin	4A	1 day	12 hours	1
Cygon 480-AG	25651	dimethoate	1B	7 days	12 hours	2
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Decis 5 EC	22478	deltamethrin	3	14 days	12 hours	2
Delegate WG	28778	spinetoram	5	1 day	12 hours	3
Entrust 80 W	27825	spinosad	5	3 days	when dry	3
Lagon 480 E	9382	dimethoate	1B	7 days	12 hours	2/3 ³
Malathion 85 E	8372	malathion	1B	3 days	12 hours	—
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Nexter	25135	pyridaben	21	10 days	24 hours	2
Oberon	28905	spiromesifen	23	3 days	12 hours	3
Pyrinex 480 EC	23705	chlorpyrifos	1B	20 days	24 hours	1
Rimon 10 EC	28881	novaluron	15	1 day	12 hours	3
Ripcord	30316	cypermethrin	3	7 days	12 hours	3
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Sluggo Professional	30025	ferric phosphate	NC	—	12 hours	—
Success	26835	spinosad	5	3 days	when dry	3
Surround WP	27469	kaolin	NC	1 day	12 hours	—
Thionex 50 WSP	29990	endosulfan	2A	12 days	7 days ⁴ / 12 days ⁵	2
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Warhawk 480 EC	29984	chlorpyrifos	1B	20 days	24 hours	1
Products used to control or suppress diseases						
Actinovate SP	28672	<i>Streptomyces lydicus</i>	NC	—	1 hour	—
Aliette	27688	fosetyl al	33	30 days	12 hours	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. P = Plant extract.

— = Information is not specified on the product label.

¹ Foliar application.

² Soil application.

³ Maximum 2 applications for tarnished plant bug or 3 applications for aphids.

⁴ Scouting, weeding, irrigation and mulching.

⁵ General re-entry.

⁶ After activation with water in soil.

⁷ Training, pinching, hand pruning and hand harvest.

⁸ Maximum 2 applications per year for 2 years.

Table 4-20. Products Used on Strawberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Bravo 500	15723	chlorothalonil	M	30 days	48 hours	3
Cabrio EG	27323	pyraclostrobin	11	1 day	12 hours	5
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper 53 W	9934	tri-basic copper sulphate	M	1 day	48 hours	5
Confine Extra	30648	phosphorous acid, mono- and di-potassium salts of	33	1 day	12 hours	5
Echo 720	29355	chlorothalonil	M	30 days	48 hours	3
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Flint	30619	trifloxystrobin	11	0 days	12 hours	3
Folpan 80 WDG	27733	folpet	M	1 day	24 hours	6
Fontelis	30331	penthiopyrad	7	0 days	12 hours	3 (max. 5.25 L/ha)
Granuflo-T	30548	thiram	M	3 days	24 hours	5
Jade	24030	propiconazole	3	1 day	12 hours	4
Maestro 80 DF	26408	captan	M	2 days	48 hours	—
Mettle 125 ME	30673	tetraconazole	3	0 days	12 hours	4
Mission 418 EC	28016	propiconazole	3	1 day	12 hours	4
MustGrow	30263	oriental mustard seed meal	—	—	24 hours ⁶	1
Nova 40 W	22399	myclobutanil	3	3 days	when dry	6
Phostrol	30449	mono and dibasic sodium, potassium and ammonium phosphites	33	3 days	12 hours	4
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	when dry ⁷ / 24 hours ⁷	5
Quadris	26153	azoxystrobin	11	365 days	when dry	1
Quintec	29755	quinoxifen	13	1 day	12 hours	4
Regalia Maxx	30199	extract of <i>Reynoutria sachalinensis</i>	P5	0 days	when dry	—
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	postharvest	—	2
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Scala SC	28011	pyrimethanil	9	1 day	12 hours	3
Scholar 230 SC	29528	fludioxonil	12	1 day	12 hours	4 ⁸
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	—
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Thiram 75 WP	27556	thiram	M	3 days	24 hours	5
Tivano	30468	citric acid + lactic acid	NC	—	when dry	—
Topas	30163	propiconazole	3	1 day	12 hours	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. P = Plant extract.

— = Information is not specified on the product label.

¹ Foliar application.² Soil application.³ Maximum 2 applications for tarnished plant bug or 3 applications for aphids.⁴ Scouting, weeding, irrigation and mulching.⁵ General re-entry.⁶ After activation with water in soil.⁷ Training, pinching, hand pruning and hand harvest.⁸ Maximum 2 applications per year for 2 years.

Notes on Strawberry Diseases and Insects

For information on the activity of fungicides on strawberry diseases, see Table 4-21. *Activity of Fungicides on Strawberry Diseases*, page 134. For information on miticides registered on strawberries, see Table 4-22. *Miticides Registered on Strawberries*, page 135.

For information on the activity of insecticides on strawberry pests, see Table 4-23. *Activity of Insecticides on Strawberry Pests and Bees*, page 136. For information on the response of different strawberry varieties to diseases, see Table 4-24. *Strawberry Variety Disease Ratings*, page 137.

Table 4-21. Activity of Fungicides on Strawberry Diseases

Please see the product label or crop calendars for registered uses. Use fungicides only for diseases listed on the product label for the crop and for the disease. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide group	Product	Angular leaf spot	Anthraxnose (C. acutatum)	Anthraxnose (C. gloeosporioides)	Botrytis grey mould	Black root rot	Common leaf spot	Leather rot	Leaf scorch	Phomopsis leaf blight and fruit rot	Phytophthora crown rot	Powdery mildew	Red stele root rot
M	Copper 53 W	2 P	1 P	1 P	1 P	—	1* P	1 P	1 P	1 P	0	1 P	0
M	Supra Captan 80 WDG	0	2	2	2*	—	3*	1	1	1 to 2	0	0	0
M	Folpan 80 WDG	0	2	2	2*	—	3*	1	—	1 to 2	0	0	0
M	Maestro 80 DF	0	2	2	2*	—	3*	1	—	1 to 2	0	0	0
M	Bravo 500	0	1	—	2*	—	1	—	1	1	0	—	0
M	Echo 720	0	1	—	2*	—	1	—	1	1	0	—	0
M	Granuflo T	0	—	—	2*	—	—	—	—	—	—	—	—
M	Thiram 75 WP	0	—	—	2*	—	—	—	—	—	—	—	—
1	Senator 70 WP	0	—	—	0 to 1* R	—	2*	—	—	—	—	2	—
2	Rovral WDG	0	0	0	3* R	—	2	0	—	0	0	0	0
3	Jade	0	0	0	0	—	3*	0	—	3	0	3	0
3	Nova 40 W	0	0	0	0	—	3	0	—	3	0	3*	0
3	Mettle 125 ME	0	0	0	0	—	3	0	—	3	0	3*	0
3	Mission 418 EC	0	0	0	0	—	3*	0	—	3	0	3	0
3	Topas	0	0	0	0	—	3*	0	—	3	0	3	0
4	Ridomil Gold SL	0	0	0	0	—	0	2	0	0	2 to 3	0	2 to 3*
7	Cantus WDG	0	—	—	3*	—	3	0	3	0	0	2	0
7	Fontelis	0	—	—	3*	—	—	0	—	—	0	—	0
7+11	Pristine WG	0	3*	3	3*	—	3*	0	3	3	0	3*	0
9	Scala SC	0	1	—	3*	—	—	0	—	—	0	—	0
9+12	Switch 62.5 WG	0	2	—	3*	—	—	0	2	2	0	1	—
11	Cabrio EG	0	3*	3	1 to 2	—	1	0	2	3	0	3	0
11	Flint	0	—	—	—	1	—	0	—	—	0	3*	0

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations.

P = May be phytotoxic. R = Pathogen resistance to the fungicide has occurred in some locations.

* (shaded area) = Disease is listed on the product label for control or suppression. — = No information is available.

Table 4-21. Activity of Fungicides on Strawberry Diseases (cont'd)

Fungicide group	Product	Angular leaf spot	Anthraxnose (C. acutatum)	Anthraxnose (C. gloeosporioides)	Botrytis grey mould	Black root rot	Common leaf spot	Leather rot	Leaf scorch	Phomopsis leaf blight and fruit rot	Phytophthora crown rot	Powdery mildew	Red stele root rot
11	Quadris	0	—	—	—	2 *	—	0	—	—	0	—	0
12	Scholar 230 SC	0	—	—	—	2 *	—	0	—	—	0	—	0
13	Quintec	0	0	0	0	—	0	0	0	0	0	3 *	0
17	Elevate 50 WDG	0	0	0	3 *	—	—	0	0	0	0	0	0
33	Aliette	0	—	—	0	—	0	2 *	0	0	2	0	2 *
33	Confine Extra	0	1	—	0	—	0	2 *	0	0	2	0	2
33	Phostrol	0	—	—	0	—	0	2 *	0	0	2	0	2
44	Serenade MAX	—	—	—	1 *	—	—	—	—	—	—	—	—
NC	Actinovate	—	1 *	1	1 *	—	—	—	—	—	—	1 *	—
NC	Tivano	1 *	—	—	—	—	—	—	—	—	—	1 *	—
P5	Regalia Maxx	—	—	—	—	—	—	—	—	—	—	1 *	—

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations.

P = May be phytotoxic. R = Pathogen resistance to the fungicide has occurred in some locations.

* (shaded area) = Disease is listed on the product label for control or suppression. — = No information is available.

Table 4-22. Miticides Registered on Strawberries

Miticide	Mite species controlled	Stage of mite controlled	Timing and comments	Preharvest interval
Apollo SC	two-spotted spider mite	eggs, very young nymphs	Apply when most mites are in the egg stage. This miticide works best if applied early in the season, when generations tend to be most synchronous.	15 days
Agri-Mek 1.9% EC	two-spotted spider mite, cyclamen mite	adults, nymphs	Apply to active mites (adults or nymphs). Agri-Mek is translaminar (locally systemic). It is absorbed best by new, expanding leaves, and less effective late in the season when foliage is hardened. It is registered for both cyclamen mite and two-spotted spider mite. Do not use with surfactants or oil.	3 days
Nexter	two-spotted spider mite	adults, nymphs	Nexter is a contact miticide providing rapid knock-down of adults and nymphs.	10 days
Oberon	two-spotted spider mite	eggs, adults, nymphs	Oberon is a slow-acting miticide which prevents eggs from hatching and nymphs from moulting to the next stage. Best used when mites are young.	3 days

Table 4-23. Activity of Insecticides on Strawberry Pests and Bees

Use products only for pests listed on the label for the crop and for the pest. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide/ Miticide	Aphids	Clipper weevils	Tarnished plant bugs	Strawberry cutworm (crown borer)	Root weevil adults	Flower thrips	Leafrollers	Potato leafhoppers	Two-spotted spider mites	Cyclamen mites	Spittle bugs	Spotted wing drosophila	Honeybees
1B	Cygon 480-AG	3 *	1	3 *	2	—	NA	3	2	0 *	0	2	NA	HT
1B	Lagon 480 E	3 *	1	3 *	2	—	NA	3	2	0 *	0	2	NA	HT
1B	Malathion 85 E	1 *	1	2	2	0	—	2 *	2 *	0	0	2	2	HT
1B	Pyrinex 480 EC	1	1	1	3 *	0	—	2	2	0	0	2	NA	HT
1B	Warhawk 480 EC	1	1	1	3 *	0	—	2	2	0	0	2	NA	HT
2A	Thionex 50 WSP	3 *	1	3 *	2	1	1	2	1	0	3 *	2 *	—	MT
3	Decis 5 EC	0	0	3 *	—	0	2	3	2	0	0	2	3	HT
3	Ripcord	0	3 *	3 *	—	2	2	3	2	0	0	2 *	3	HT
3	Matador 120 EC	0	3 *	3 *	—	2 *	2	3	2	0	0	2 *	3	HT
3	Silencer 120 EC	0	3 *	3 *	—	2 *	2	3	2	0	0	2 *	3	HT
3	Up-Cycle 2.5 EC	0	3 *	3 *	—	2	2	3	2	0	0	2 *	3	HT
4	Actara 25 WG	2	2	1	—	2 *	—	—	1	0	0	—	—	HT
4	Admire 240 F	3 *	2	—	—	1	—	—	3 *	0	0	—	—	HT
4	Alias 240 SC	3 *	2	—	—	1	—	—	3	0	0	—	—	HT
4	Assail 70 WP	3 *	—	2 *	—	—	—	—	3 *	0	0	2	1	MT
4	Clutch 50 WDG	—	3	2 *	—	2	—	—	—	—	—	—	—	HT
5	Delegate WG	—	—	—	2	—	2 *	2	—	0	0	—	3	HT
5	Entrust 80 W	0	—	—	2	—	2	3 *	—	0	0	—	3	HT
5	Success	0	—	—	2	—	2	3 *	—	0	0	—	3	HT
6	Agri-Mek 1.9% EC	0	0	0	0	0	1	0	1	3 *	2 *	—	0	HT
10	Apollo SC	0	0	0	0	0	0	0	0	3 *	0	0	0	S
11	Bioprotec CAF	0	0	0	—	0	0	2 *	0	0	0	0	0	S
11	Dipel 2X DF	0	0	0	—	0	0	2 *	0	0	0	0	0	S
15	Rimon 10 EC	—	—	3 *	—	—	—	3	—	0	0	—	0	MT ¹
21	Nexter	0	0	0	0	0	0	0	0	3 *	2	0	0	HT
23	Oberon	0	0	0	0	0	0	0	0	3 *	—	0	0	S
28	Altacor	0	—	0	—	—	—	3 *	0	0	0	0	0	S
NC	Surround WP	—	—	—	—	—	NA	—	2 *	2	—	—	—	I

0 = No control. 1 = Poor to fair control. 2 = Good control, some limitations. 3 = Excellent control, few if any limitations. NA = Not used at the timing for this pest.

* (shaded area) = Pests are listed on the product label for control or suppression. — = No information is available.

Bee toxicity: HT = Highly toxic. MT = Moderately toxic. S = Relatively safe or non-toxic. I = Irritant.

¹ Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area.

Table 4-24. Strawberry Variety Disease Ratings

Variety	Leaf spot ^a	Leaf scorch ¹	Powdery mildew	Botrytis grey mould	Verticillium	Red stele ²	Bacterial angular leaf spot ³	Black root rot	Anthraxnose fruit rot
Albion	MR	—	MR	S	R	—	—	—	MR
Allstar	MR	I	MR	MR	MR	S	HS	S	—
Annapolis	MR	MR	S	S	MR	R	HS	—	S
Brunswick	MR	MR	MR	MR	—	R	—	MR	—
Cabot	MR	MR	R	S	S	R	—	MR	—
Cavendish	MR	R	S	MR	MR	R	HS	MR	S
Evangeline	MR	R	MR	MR	S	S	—	S	—
Glooscap	MR	MR	MR	S	S	S	S	—	—
Gov. Simcoe	MR	MR	HS	S	MR	S	S	—	S
Honeoye	MR	MR	MR	MR	HS	S	HS	S	—
Jewel	MR	MR	S	MR	S	S	HS	HS	—
Kent	HS	HS	MR	S	S	S	HS	HS	S
L'Amour	—	—	S	MR	—	MR	S	MR	—
Micmac	S	HS	MR	S	MR	S	S	—	—
Mira	HS	R	R	MR	S	R	S	S	—
Mohawk	MR	MR	MR	MR	MR	MR	—	—	—
Sable	R	R	S	S	—	R	HS	—	—
St. Pierre	MR	S	MR	R	—	S	—	—	S
Sapphire	—	MR	MR	—	—	—	—	—	—
Seascope	S	—	HS	—	—	—	—	—	—
Serenity	—	MR	MR	—	—	—	—	—	S
Sparkle	S	MR	MR	MR	S	HR	S	—	—
Summer Dawn	S	S	—	—	—	—	—	—	HS
Summer Rose	—	—	—	—	—	—	—	—	S
Summer Ruby	—	—	—	—	—	—	—	—	S
Summer Evening	—	—	—	—	—	—	—	—	S
Tribute	MR	MR	S	MR	R	MR	—	—	—
Tristar	MR	MR	S	MR	R	MR	MR	—	—
Valley Sunset	—	—	—	S	—	—	S	—	—
Veestar	S	MR	S	MR	MR	HS	S	—	—
Wendy	S	MR	MR	MR	S	MR	HS	S	—

HR = Highly Resistant. R = Resistant. MR = Moderately Resistant. S = Susceptible. HS = Highly Susceptible.

— = No information is available.

^a Race dependent.

¹ Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996, for some cultivars.

² Red stele ratings from Dr. N. Nickerson and Dr. A. Jamieson, Agriculture and Agri-Food Canada, Kentville, Nova Scotia.

³ P.D. Hildebrand, P.G. Braun et. al. *Can. J. Plant Pathol.* 27:16–24 (2005) and field observation.

STRAWBERRY NOTES

5. Grapes

Grape Nutrition

Test the soil a year in advance of planting grape vines, or two years before planting where pH adjustment may be necessary. Some soil amendments do not move readily through the soil profile, but are needed to optimize vineyard productivity. These materials include organic matter, phosphorus, potassium and lime to adjust soil pH. The only opportunity to thoroughly incorporate these materials is before planting.

Manure for Vineyards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and provides many macro- and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for several years after application. When manure is used, adjust applied inorganic nitrogen fertilizers to avoid over-applications. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, excessive growth and delayed hardening of the woody tissue, which may make plants more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid) or 35 tonnes/ha of hog manure (65 m³ liquid). Since the nutrient content of manure varies considerably, it should be tested before application. See *Manure nitrogen*, page 16.
- Broadcast manure and work it into the soil in late fall or early spring before planting.
- Do not place manure around newly planted vines in late summer as winter injury may result.
- Adjust the rate of nitrogen, phosphorus and potassium fertilizers applied according to the nutrient content of the manure. See Table 2-10, *Average Fertilizer Replacement Values for Manure*, page 16.

- For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen* and *Use manure responsibly*, page 16.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime at the suggested rates prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, page 12.

In established vineyards, sample soil in the vine row every three years to ensure the pH is satisfactory. If pH is low or acidic, apply lime in the fall to the sod cover or before spring cultivation. The results will not be immediate because lime reacts slowly in the soil. Apply lime to established vineyards when the pH drops below 5.1 on clay loam soils or 5.6 on sandy soils. Lime raises the soil pH and also supplies calcium. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, page 12.

Petiole Analysis

In established plantings, the best way to determine the nutrient status of the vines is by petiole analysis. In conjunction with soil analysis, it provides good information for adjusting fertilizer rates. For more information on these tests, see *Plant tissue analysis*, page 10.

Nutrient uptake is affected by many vineyard conditions and varies slightly from year to year, depending on the season. To obtain optimum growth and fruit quality, all nutrients must be present in sufficient concentrations. See Table 5-1, *Nutrient Sufficiency Range of Grape Petioles*, page 140.

For petiole analysis to be most useful, sample the same vines each year. Use these tests along with other factors, including soil testing, rootstock, and vine age to determine the fertilizer program.

Table 5-1. Nutrient Sufficiency Range of Grape Petioles¹

	Nitrogen (N)	Phosphorus (P)	Potassium (K) ²	Calcium (Ca)	Magnesium (Mg)	Iron (Fe)	Boron (B)	Zinc (Zn)	Manganese (Mn)
Variety	%					ppm			
Vinifera	0.8–1.4	0.15–0.4	1.2–2.3	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Labrusca (Fredonia)	0.6–1.2	0.15–0.4	0.8–1.8	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Other	0.7–1.3	0.15–0.4	1–2	1–3	0.6–1.5	15–100	20–60	15–100	20–200

¹ Taken in September from mature vines.² Potassium levels may be higher in grapes grown on sandy loam soils.

Fertilizer for Grapes

The best time to effectively incorporate nutrients such as potassium, phosphorus, boron and lime into the soil is prior to planting the vineyard. Nutrient levels in the topsoil adequate for vineyard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 5-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes* on this page provides fertilizer rates prior to planting. Along with incorporation of organic matter such as manure, these fertility levels will sustain the vineyard through the juvenile years.

High nitrogen levels can result in excessive growth and incomplete vine hardening. Use cover crops to reduce late-season nitrogen levels in cultivated vineyards, especially in new plantings. Sow cover crops such as Italian ryegrass about July 1 to take up much of the available nitrogen in the soil.

Nitrogen (N)

Use petiole analysis to determine nitrogen requirements. Use 34 kg of nitrogen per ha only if this information is not available. Broadcast nitrogen before the first cultivation. In vineyards with sod between the rows, apply nitrogen as early as possible in the spring. Where urea (46-0-0) is applied, it must be incorporated to reduce losses by volatilization. Do not use urea in vineyards with sod between the rows because incorporation is not possible. Reduce rates or eliminate nitrogen entirely if manure is used or growth has been excessive. If severe winter temperatures cause fruit bud damage, it may be necessary to split nitrogen applications. Apply the first application in early May, and the second application, if necessary, after bloom in late June. During dry springs, use irrigation to move the fertilizer into the rooting zone just before first bloom or immediately after capfall. Consider foliar applications of nitrogen if vine performance and petiole analysis suggest the need.

Phosphorus (P)

Grapes do not require high levels of soil phosphorus. With a few exceptions, the level of phosphorus in Ontario soils is adequate for grapes. Use a soil test to determine if phosphorus fertilizer is required. A phosphorus soil test value between 12–20 ppm is adequate for vineyard establishment and production. When establishing a new planting, apply phosphorus before planting and thoroughly incorporate it into the soil. See Table 5-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes* on this page. In established plantings, use petiole analysis along with soil analysis to estimate phosphorus requirements. Additional phosphorus may be needed for sod or cover crop maintenance.

Table 5-2. Phosphorus and Potassium Soil Requirements for New Plantings of Grapes

Phosphorus		Potassium*	
Soil test (ppm P)	Phosphate (P ₂ O ₅) required (kg/ha) [response]	Soil test (ppm K)	Potash (K ₂ O) required (kg/ha) [response]
0–3	80 [HR]	0–15	270 [HR]
4–5	60 [HR]	16–30	270 [HR]
6–7	50 [HR]	31–45	270 [HR]
8–9	40 [MR]	46–60	270 [HR]
10–12	20 [MR]	61–80	270 [HR]
13–15	0 [LR]	81–100	270 [HR]
16–20	0 [LR]	101–120	270 [HR]
21–25	0 [RR]	121–150	270 [MR]
26–30	0 [RR]	151–180	270 [MR]
31–40	0 [RR]	181–210	270 [MR]
41–50	0 [RR]	211–250	270 [LR]
51–60	0 [RR]	250+	270 [LR]
61–80	0 [NR]		
80+	0 [NR]		

* For new plantings, apply only every second year. For established grapes, use plant analysis to estimate requirements of N, P and K.

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

Table 5-3. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 10 days apart beginning in mid-July	Magnesium sulphate (Epsom salts)	20 kg/1,000 L water	Wet plant to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Potassium (K)

Grapes require larger amounts of potassium than tree fruits. In established plantings, use petiole analysis along with soil analysis to estimate potassium to determine requirements. Excess potassium can lead to deficiency of magnesium (Mg). Avoid unnecessary potassium applications.

Prior to establishment, incorporate potassium according to Table 5-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes*, page 140. In established cultivated vineyards, broadcast potassium before the first cultivation in the spring. In established vineyards with sod between the rows, and in vineyards on clay soils, apply potassium in a band to reduce potassium fixation and increase its availability to the vines. Muriate of potash (0-0-60, potassium chloride) can injure roots and trunks if applied too closely to the trunk.

Foliar application of potassium for grapes

In dry growing seasons, potassium is not readily available to the plant. When a potassium deficiency occurs, foliar applications of potassium may help. Foliar potassium applied at veraison (when grapes begin to ripen) may improve fruit yield and quality.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are adequate for grapes. Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply magnesium. Magnesium deficiency has become more evident in vineyards, particularly when high rates of potassium are used.

Magnesium deficiency can lead to premature fruit drop. Because magnesium is a part of the chlorophyll molecule, magnesium-deficient vines have older leaves that are pale in colour. Petiole analysis is the best way to evaluate magnesium levels.

Foliar sprays correct magnesium deficiency for the current year only. For long-term corrections, apply magnesium to the soil in early spring. On some soil

types, a single early-spring application of soil-applied magnesium may not be enough. A second or third application the next spring may be required before the magnesium level in the plant improves.

Foliar sprays are recommended for the first 2 years, in addition to soil applications. See Table 5-3. *Magnesium Foliar Sprays* on this page.

Fruit or foliage injury may occur if pesticides are mixed with magnesium sulphate (Epsom salts). Pesticides should be applied as a separate spray. Check the manufacturer's label about mixtures of magnesium chelates with pesticides. Use only chelates recommended for foliar sprays.

Calcium (Ca)

Calcium deficiency has been associated with rachis (cluster stem) breakdown of Canada Muscat and Himrod grapes. This deficiency is usually associated with water uptake imbalances in the vine during bloom and immediately post fruit set. It is difficult to correct with calcium foliar sprays.

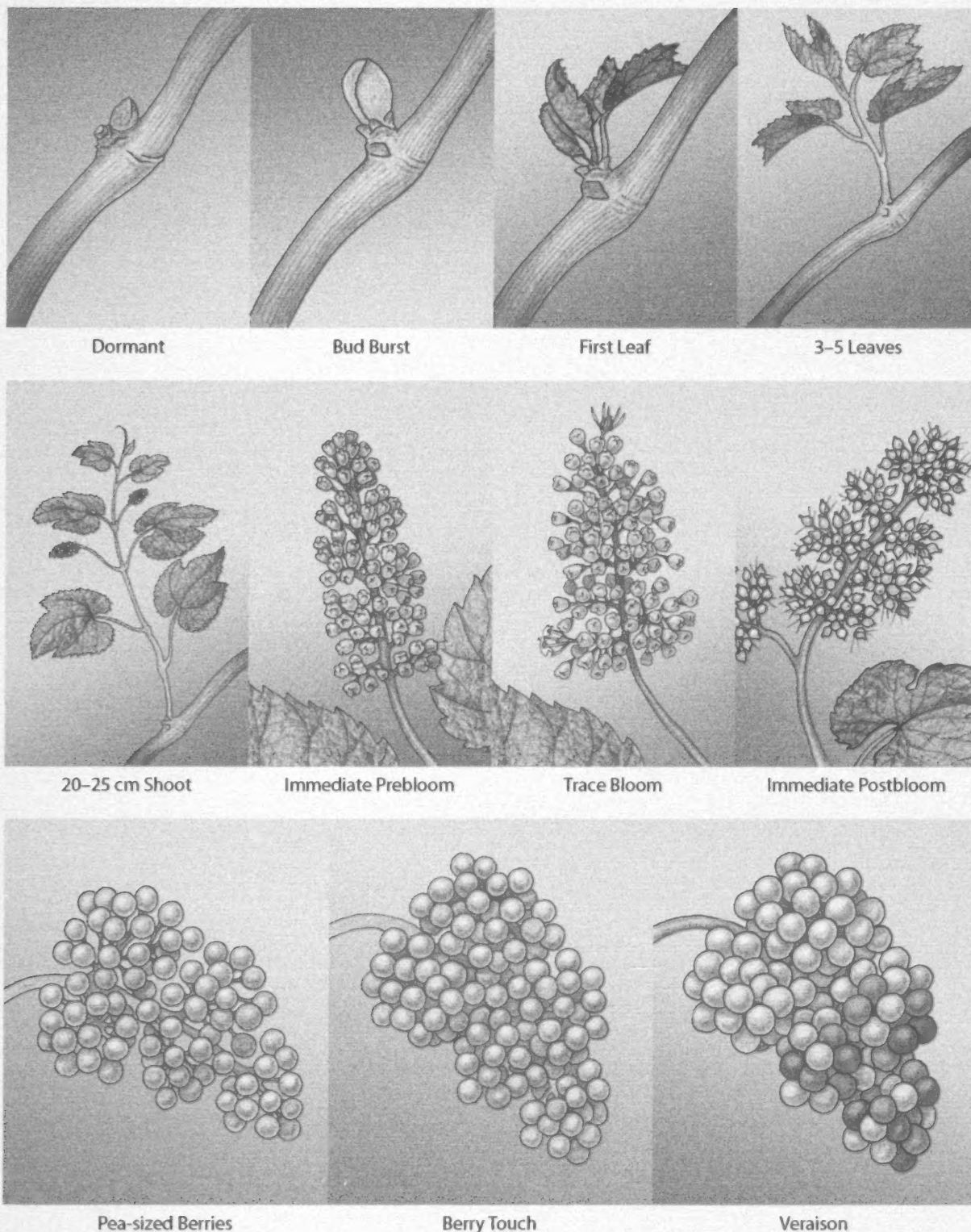
Micronutrients

Deficiencies of micronutrients are not widespread in Ontario plantings. The desirable range for micronutrients is quite narrow. Micronutrients applied in excess can cause more damage than deficiencies. For this reason, do not apply micronutrients unless petiole analysis confirms a deficiency. Apply only the nutrient that is deficient and only in sufficient quantities to correct the problem.

Lime-induced chlorosis is a deficiency in iron or manganese occasionally induced by alkaline soils with high soil bicarbonates or by excessive lime application. For additional information, see *Micronutrients*, page 21.

Apply nutrients according to recommended rates on the product label. Do not spray during temperatures above 25°C.

Figure 5-1. Grape Growth Stages



Grape Calendar

Read the product label and follow all safety precautions. Some grape varieties are sensitive to sulphur, copper, Flint, Pristine, or other products. See Table 5-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 156, for specific information.

For preharvest intervals, re-entry periods, and maximum number of applications, see Table 5-4. *Products Used on Grapes*, page 153.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and others have unknown modes of action (U or UN).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Use co-formulations or products that must be tank-mixed with another chemical group no more than 3 times per season.
- Use products containing only one chemical family no more than twice per season.
- Do not use Nova, Inspire, Mettle, Sovran, Flint, Quintec, Vivando, Cantus, Revus, Pristine, Presidio, Acrobat, Zampro, Luna Tranquility, Rovral, Scala, Vanguard, Elevate or Switch when sporulating lesions of the target disease are present.
- Use sufficient water to provide thorough coverage.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (grape berry moth), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with rapidly building and overlapping generations (mites, leafhoppers, phylloxera), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to grapes during bloom – do not apply them while bees are active in the vineyard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Preharvest Intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 5-4. *Products Used on Grapes*, page 153, are taken from product labels. In some cases, regulations on residues in finished products are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the grape purchaser for more details.

Spray Water Volumes

Sufficient water volumes are necessary to provide complete coverage with grape fungicides, miticides and insecticides. Increased water volumes are necessary as the season progresses and canopies grow. Canopy management through hedging, leaf-pulling and shoot thinning, as well as proper sprayer calibration, is critical to ensure proper spray coverage. Sufficient coverage and efficacy are not possible if water volumes are inadequate. Some types of sprayers are able to provide sufficient coverage with less water than others. Consult equipment dealers or professional crop consultants about the amount of water needed to ensure adequate coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage. Read and follow water volume requirements on all product labels.

Disease or Insect	Product (Group)	Rate	Comments
Bud burst to first leaf			
Climbing cutworm	• Pounce 384 EC (3)	180 mL/ha	Pounce: Increase rate to 360 mL/ha if cutworms are large (2–3 cm). Apply in at least 450 L of water per ha. Spray trunk and soil surface within 0.5 m of the trunk in the evening. Do not disturb the soil for 5 days after spraying. Altacor: Apply when cutworms start feeding on buds. Maximum of 2 applications per season.
	• Altacor (28)	285 g/ha	
First leaf, 1.25–5-cm shoot length			
Phomopsis cane and leaf spot	• Supra Captan 80 WDG (M)	1.2 kg/1,000 L water	Spray susceptible varieties, especially if the weather is wet and there is a history of phomopsis in the vineyard. Alternate row spraying will not give adequate protection from phomopsis. See Table 5-5. <i>Relative Susceptibility of Grape Cultivars to Diseases</i> , page 156.
	• Maestro 80 DF (M)	2 kg/ha	
	• Folpan 80 WDG (M)	1.25 kg/ha	
3–5 leaves unfolded, 10–15-cm shoot length			
Erineum mite	• Kumulus DF (NC)	3.4 kg/ha	Apply immediately after the first evidence of erineum mite development and again at mid-season. Do not use on Concord, Foch, or deChaunac varieties.
	• Microthiol Disperss (NC)	3.4 kg/ha	
Phomopsis cane and leaf spot	Use one of the products listed for phomopsis cane and leaf spot at First leaf, 1.25–5-cm shoot length .		
Black rot	• Ferbam 76 WDG (M)	2 kg/1,000 L water	Spray susceptible varieties, especially where there is a history of black rot and conditions are wet. Alternate row spraying will not give adequate protection from black rot. Copper 53W: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Copper</i> , page 253. Do not apply to Vidal, Concord or Niagara varieties. Nova, Mettler: These products are locally systemic. Consult labels for information on drying time required before rain.
	• Polyram DF (M)	2 kg/1,000 L water	
	• Penncozeb 75 DF Raincoat (M)	2.13 kg/1,000 L water (or 7.2 kg/ha)	
	• or Manzate Pro-Stick (M)	2.13 kg/1,000 L water (or 7.2 kg/ha)	
	• Copper 53W (M)	3 kg + 6 kg lime/1,000 L water	
	• Nova 40 W (3)	200 g/ha	
• Mettler 125 ME (3)	292–365 mL/ha		

Disease or Insect	Product (Group)	Rate	Comments
Powdery mildew	• Microscopic Sulphur (M) or Kumulus DF (M)	4.5 kg/1,000 L water 4.2 kg/1,000 L water (or 12.6 kg/ha)	Unless otherwise indicated, apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters before symptoms appear. Apply at 7-day intervals if weather is conducive to disease or if rapid shoot growth is occurring. Alternate row spraying will not give adequate protection from powdery mildew. Nova, Inspire, Mettle, Luna Tranquility, Quintec, Vivando: These products are locally systemic. Consult labels for information on drying time required before rain. Serenade MAX, Buran, Regalia Maxx, Purespray Green Spray Oil: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242. MilStop, Sirocco: Use the lower rate in 500 L of water and the higher rate in 1,000 L of water. Create a mildly alkaline solution. Do not tank-mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. Work as eradicants and have no protective activity. Buran: This is a new product in Ontario and little evidence of its efficacy is available. Purespray Green Spray Oil 13E: Apply in a minimum of 1,000 L water/ha (1% solution). Tolerance has not been determined for all varieties; test a small area of each variety prior to spraying the whole block. Do not apply within 14 days of captan, folpet, permethrin or sulphur. Do not apply within 48 hours of freezing temperatures, when temperatures are high (above 25°C), to crops under moisture stress, or just prior to rain. Regalia Maxx: Apply before symptoms develop. Use 0.125% (1.25 L in 1,000 L water) in a tank-mix with other powdery mildew fungicides or 0.25% (2.5 L in 1,000 L water) in rotation with other powdery mildew fungicides. Vivando: Do not apply at intervals of less than 14 days.
	• or Microthiol Disperss (M)	4.2 kg/1,000 L water (or 12.6 kg/ha)	
	• Nova 40 W (3)	200 g/ha	
	• Inspire (3)	292 mL/ha	
	• Mettle 125 ME (3)	219–365 mL/ha	
	• Luna Tranquility (7+9)	600 mL/ha	
	• Quintec (13)	300 mL/ha	
	• Serenade MAX (44)	3–6 kg/ha	
	• MilStop (NC) or Sirocco (NC)	2.8–5.6 kg/ha 2.8–5.6 kg/ha	
	• Buran (NC)	18 L/ha	
	• Purespray Green Spray Oil 13E (NC)	10 L/1,000 L water	
	• Regalia Maxx (P5) 500–1,500 L water	0.125–0.25% v/v in	
	• Vivando SC (U8)	750 mL/ha	
Shoot length 20–25 cm			
Erineum mite	Use one of the products listed for erineum mite at 3–5 leaves unfolded, 10–15-cm shoot length.		
Phylloxera (leaf form)	• Assail 70 WP (4)	80 g/ha	Movento: Apply when galls are first observed. Will redistribute to young leaves as they develop. Control may not be apparent for 2–3 weeks. Consecutive applications should be at least 30 days apart. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v (2 L/1,000 L). See label for further details.
	• Movento 240 SC (23)	365 mL/ha	
Grape berry moth (GBM)	• Isomate-GBM Plus	500 dispensers/ha	Reduces mating of GBM. Apply prior to first flight. Border sprays of insecticide or higher rates of pheromone (1,000 dispensers/ha) may be required where pressure is high. Dispensers last up to 150 days. See <i>Mating Disruption in Fruit Crops</i> , page 250.
Phomopsis cane and leaf spot	Use one of the products listed for phomopsis cane and leaf spot at First leaf, 1.25–5-cm shoot length.		
Black rot	• Polyram DF (M)	2 kg/1,000 L water	Spray susceptible varieties, especially where there is a history of black rot and conditions are wet. Alternate row spraying will not give adequate protection from black rot. Copper 53W: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Copper</i> , page 253. Do not apply to Vidal, Concord or Niagara varieties. Nova, Mettle, Sovran, Flint, Pristine: These products are locally systemic. Consult labels for information on drying time required before rain. Mettle: Under high disease pressure, use high rate. Sovran: Phytotoxic to some cherry varieties (see label); do not let product drift onto sensitive crops. Flint: Do not apply to Concord grapes. Pristine: When used as directed, will help reduce anthracnose. Do not use on Concord, Fredonia or related varieties.
	• Penncozeb 75 DF Raincoat (M)	2.13 kg/1,000 L water (7.2 kg/ha)	
	• or Manzate Pro-Stick (M)	2.13 kg/1,000 L water (7.2 kg/ha)	
	• Copper 53W (M)	3 kg + 6 kg lime/ 1,000 L water	
	• Nova 40 W (3)	200 g/ha	
	• Mettle 125 ME (3)	292–365 mL/ha	
	• Sovran (11)	240 g/ha	
	• Flint (11)	140 g/ha	
	• Pristine WG (11+7)	735 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Powdery mildew	• Microscopic Sulphur (M) or Kumulus DF (M)	4.5 kg/1,000 L water 4.2 kg/1,000 L water (or 12.6 kg/ha)	Unless otherwise indicated, apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters before symptoms appear. Apply at 7-day intervals if weather is conducive to disease or if rapid shoot growth is occurring. Alternate row spraying will not give adequate protection from powdery mildew. Nova, Inspire, Mettle, Cantus, Luna Tranquility, Pristine, Sovran, Flint, Quintec, Vivando: These products are locally systemic. Consult labels for information on drying time required before rain. Sovran: Phytotoxic to some cherry varieties (see label); do not let product drift onto sensitive crops. Flint: Do not apply to Concord grapes. Pristine: When used as directed, will help reduce anthracnose. Do not use on Concord, Fredonia or related varieties. Serenade MAX, Regalia Maxx, Purespray Green Spray Oil: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. MilStop, Sirocco: Use the lower rate in 500 L of water and the higher rate in 1,000 L of water. Create a mildly alkaline solution. Do not tank-mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. Work as eradicants and have no protective activity. Buran: This is a new product in Ontario and little evidence of its efficacy is available. Purespray Green Spray Oil 13E: Apply in minimum of 1,000 L water/ha (1% solution). Tolerance has not been determined for all varieties; test a small area of each variety prior to spraying the whole block. Do not apply within 14 days of captan, folpet, permethrin or sulphur products. Do not apply within 48 hours of freezing temperatures, when temperatures are high (above 25°C), to crops under moisture stress, or prior to rain. Regalia Maxx: Apply before symptoms develop. Use 0.125% (1.25 L in 1,000 L water) in a tank-mix with other powdery mildew fungicides or 0.25% (2.5 L in 1,000 L water) in rotation with other powdery mildew fungicides. Vivando: Do not apply at intervals of less than 14 days.
	• Microthiol Disperss (M)	4.2 kg/1,000 L water (or 12.6 kg/ha)	
	• Nova 40 W (3)	200 g/ha	
	• Inspire (3)	292 mL/ha	
	• Mettle 125 ME (3)	219–365 mL/ha	
	• Cantus (7)	315 g/ha	
	• Luna Tranquility (7+9)	600 mL/ha	
	• Pristine (7+11)	420–735 g/ha	
	• Sovran (11)	300 g/ha	
	• Flint (11)	140 g/ha	
	• Quintec (13)	300 mL/ha	
	• Serenade MAX (44)	3–6 kg/ha	
	• MilStop (NC) or Sirocco (NC)	2.8–5.6 kg/ha 2.8–5.6 kg/ha	
	• Buran (NC)	18 L/ha	
	• Purespray Green Spray Oil 13E (NC)	10 L/1,000 L water	
	• Regalia Maxx (P5)	0.125–0.25% v/v in 500–1,500 L water	
	• Vivando SC (U8)	750 mL/ha	

Disease or Insect	Product (Group)	Rate	Comments
Downy mildew	• Polyram DF (M)	2 kg/1,000 L water	Apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters. Apply at shorter intervals if weather is conducive to disease. Consult label for information on dry time required before rain. Copper Spray, Guardsman Copper Oxychloride, Copper 53W: Do not apply to Vidal, Concord or Niagara varieties. See notes on Copper, page 253. Kocide: Always test for sensitivity. The addition of 454–1,360 g hydrated lime per 454 g of Kocide 2000 may reduce phytotoxicity. Pristine, Sovran, Revus: These products are locally systemic. Ridomil Gold MZ, Phostrol, Rampart, Confine Extra, Aliette, Acrobat, Zampro: These products are fully systemic and will redistribute to young leaves as they develop. Pristine: When used as directed, will help reduce anthracnose. Sovran: Phytotoxic to some cherry varieties (see label); do not let product drift onto sensitive crops. Phostrol, Rampart, Confine Extra: Use the lower rate in 500 L of water and the higher rate in 1,000 L of water. Phytotoxicity may occur if concentration is increased above the label rate or tank-mixed with a surfactant. Apply at 1–3-week intervals, using the high rate and short interval under high disease pressure. Rampart: Do not apply to vines that are dormant or heat-stressed. Do not apply in less than 20-day intervals with copper-based compounds. Do not apply when conditions favour prolonged wet periods (>4 hours). Revus: Use with a non-ionic adjuvant (0.125% or 1.25 L/1,000 L water). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Acrobat: Tank-mix with another downy mildew fungicide from a different chemical group. Acrobat, Zampro: Do not use less than 200 L water/ha. Tivano: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. This is a new product in Ontario and little evidence of its efficacy is available. Test on a small scale before using more broadly. Apply in 200 L water/ha. Use high rate and short intervals under moderate to high disease pressure. Attain better coverage using surfactant LI700. Re-apply at 7–10-day intervals as needed. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Penncozeb 75 DF Raincoat (M)	2.13 kg/1,000 L water (or 7.2 kg/ha)	
	or Manzate Pro-Stick (M)	2.13 kg/1,000 L water (or 7.2 kg/ha)	
	• Supra Captan 80 WDG (M)	1.5 kg/1,000 L water	
	or Maestro 80 DF (M)	2 kg/ha	
	• Folpan 80 WDG (M)	1.25 kg/ha	
	• Copper Spray (M)	3 kg + 6 kg lime/1,000 L water	
	• Guardsman Copper Oxychloride 50 (M)	3 kg + 6 kg lime/ha	
	• Copper 53W (M)	3 kg + 6 kg lime/1,000 L water	
	• Kocide 2000 (M)	1.6 kg/ha	
	• Ridomil Gold MZ 68 WG (4+M)	2.5 kg/ha	
	• Pristine WG (7+11)	675–735 g/ha	
	• Sovran (11)	300 g/ha	
	• Gavel 75 DF (22+M)	2.25 kg/ha	
	• Phostrol (33)	2.9–5.8 L/ha	
	or Rampart (33)	2.5–5 L/ha	
	or Confine Extra (33)	2.9–5.8 L/ha	
	• Aliette (33)	3.75 kg/ha	
	• Revus (40)	500 mL/ha	
	• Acrobat 50 WP (40)	450 g/ha	
	• Zampro (40+45)	0.8–1.0 L/ha	
	• Tivano (NC)	16–24 L/ha	

Disease or Insect	Product (Group)	Rate	Comments
Immediate prebloom			
Erineum mite	Use one of the products listed for erineum mite at 3–5 leaves unfolded, 10–15-cm shoot length .		
Grape berry moth (First generation)	• Imidan 70-WP Instapak (1) • Sevin XLR (1) • Pounce 384 EC (3) • or Perm-Up (3) • or Ambush 500 EC (3) • Up-Cyde 2.5 EC (3) • Delegate WG (5) • Success (5) • Entrust SC (5) • Dipel 2X DF (11) • or BioProtec CAF (11) • Altacor (28)	1.36 kg/ha 5.25 L/ha 360 mL/ha 360 mL/ha 275 mL/ha 240 mL/ha 280 g/ha 182 mL/ha 364 mL/ha 1.125 g/ha 2.8 L/ha 285 g/ha	Apply where there is a history of early season injury. Re-apply if flight is extended. Direct spray at fruiting zone. Imidan: Be aware of current label changes with respect to rates, restrictions and precautions. See Table 5-4. <i>Products Used on Grapes</i> , page 153. Delegate, Success, Entrust, Altacor, Dipel, Bioprotec: Apply at first egg hatch (first sustained moth catch in pheromone traps), earlier than the traditional timing (upswing in moth numbers captured in traps) used for Group 3 insecticides or Imidan. Delegate, Success, Entrust: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Dipel, BioProtec: Re-apply 7–10 days later, if needed.
Japanese beetle	• Imidan 70-WP Instapak (1) • Assail 70 WP (4) • Altacor (28)	1.36 kg/ha 80 g/ha 285 g/ha	Japanese beetle is a sporadic pest in Ontario. Monitor presence and extent of feeding damage. Where damage is localized, spot treatment may be adequate. Imidan: Be aware of current label changes with respect to rates, restrictions and precautions. See Table 5-4. <i>Products Used on Grapes</i> , page 153. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply when feeding is first observed and re-apply in 10–14 days, if needed.
Leafhoppers	• Sevin XLR (1) • Pounce 384 EC (3) • or Perm-Up (3) • or Ambush 500 EC (3) • Up-Cyde 2.5 EC (3) • Pyganic EC 1.4 11 (3) • Assail 70 WP (4) • Clutch 50 WDG (4) • Admire 240 F (4) • Closer SC (4) • Surround WP (NC)	5.25 L/ha 175 mL/ha 175 mL/ha 140 mL/ha 240 mL/ha 2.32–4.65 L/ha 80 g/ha 100–140 g/ha 200 mL/ha 200–400 mL/ha 50 kg/ha	Grape leafhopper (GLH), potato leafhopper (PLH) and three-banded leafhopper (TBLH) are the main species of leafhoppers that feed on grapes. Pyganic: Use high rate for maximum efficacy. Adjust spray solution to pH of 5.5–7.0, if outside that range. If possible, apply in the early morning or evening hours. Apply promptly after mixing. Apply when pests are first observed; do not wait until plants are heavily infested. Re-apply if necessary after 7 days. Before making widespread applications, treat a small area and observe for phytotoxicity over a 10-day period. Closer: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Surround WP: May delay sugar accumulation. Closely monitor harvest parameters to determine best time to harvest. Use 50 kg/ha for the initial 2 applications to establish the protectant layer, followed by 25 kg/ha in subsequent sprays. Re-apply to maintain complete coverage following heavy rain. Do not apply Surround postbloom on table grapes. See <i>Using Organic and Biopesticide Products</i> , page 242.
Phylloxera (leaf form)	• Assail 70 WP (4) • Clutch 50 WDG (4) • Movento 240 SC (23)	80 g/ha 140–210 g/ha 365 mL/ha	Only French hybrid and vinifera varieties are susceptible to this pest. Movento: Will redistribute to young leaves as they develop. Control may not be apparent for 2–3 weeks. Consecutive applications should be at least 30 days apart. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details.

Disease or Insect	Product (Group)	Rate	Comments
Trace bloom (first cap fall)			
DO NOT APPLY INSECTICIDES WHILE GRAPES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Black rot	Use one of the products listed for black rot at Shoot length 20–25 cm . Fruit clusters are highly susceptible to black rot from bloom to 4 weeks postbloom. Apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters. Apply at shorter intervals if weather is conducive to disease.		
Downy mildew	• Polyram DF (M) • Penncozeb 75 DF Raincoat (M) - or Manzate Pro-Stick (M) • Supra Captan 80 WDG (M) - or Maestro 80 DF (M) • Folpan 80 WDG (M) • Copper Spray (M) • Guardsman Copper Oxychloride 50 (M) • Copper 53W (M) • Kocide 2000 (M) • Ridomil Gold MZ 68 WG (4+M) • Pristine WG (7+11) • Sovran (11) • Gavel 75 DF (22+M) • Phostrol (33) - or Rampart (33) - or Confine Extra (33) • Aliette (33) • Revus (40) • Acrobat 50 WP (40) • Zampro (40+45) • Presidio (43) • Tivano (NC)	2 kg/1,000 L water 2.13 kg/1,000 L water (or 7.2 kg/ha) 2.13 kg/1,000 L water (or 7.2 kg/ha) 1.5 kg/1,000 L water 3.5 kg/ha 1.25 kg/ha 3 kg + 6 kg lime/1,000 L water 3 kg + 6 kg lime/1,000 L water 1.6 kg/ha 2.5 kg/ha 675–735 g/ha 300 g/ha 2.25 kg/ha 2.9–5.5 L/ha 2.5–5.0 L/ha 2.5–5.8 L/ha 3.75 kg/ha 500 mL/ha 450 g/ha 0.8–1.0 L/ha 220–292 mL/ha 16–24 L/ha	Fruit clusters are highly susceptible to downy mildew from bloom to 4–6 weeks postbloom. Apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters. Apply at shorter intervals if weather is conducive to disease. Consult label for information on drying time required before rain. Copper Spray, Guardsman Copper Oxychloride, Copper 53W: Do not apply on Vidal, Concord or Niagara varieties. See notes on Copper, page 253. Kocide: Always test for sensitivity. The addition of 454–1,360 g hydrated lime per 454 g of Kocide may reduce phytotoxicity. Pristine, Sovran, Revus, Presidio: These products are locally systemic. Ridomil Gold MZ, Phostrol, Rampart, Confine Extra, Aliette, Acrobat, Zampro: These products are fully systemic and will redistribute to young leaves as they develop. Pristine: When used as directed, will help reduce anthracnose. Do not use on Concord, Fredonia or related varieties. Sovran: Phytotoxic to some cherry varieties (see label); do not let product drift onto sensitive crops. Phostrol, Rampart, Confine Extra: Use the low rate in 500 L of water and the high rate in 1,000 L of water. Phytotoxicity may occur if concentration is increased above the label rate or tank-mixed with a surfactant. Rampart: Do not apply to vines that are dormant or heat-stressed. Do not apply in less than 20-day intervals with copper-based compounds. Do not apply when conditions favour prolonged wet periods (>4 hours). Revus: Use with a non-ionic adjuvant (0.125% or 1.25 L/1,000 L water). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Acrobat, Presidio: Tank-mix with another downy mildew fungicide from a different chemical group. Acrobat, Zampro: Do not use less than 200 L water/ha. Tivano: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. This is a new product in Ontario and little evidence of its efficacy is available. Test on a small scale before using more broadly. Apply in 200 L water/ha. Use high rate and short intervals under moderate to high disease pressure. Re-apply at 7–10-day intervals, as needed. See <i>Using Organic and Biopesticide Products</i>, page 242.
Powdery mildew	Use one of the products listed for powdery mildew at Shoot length 20–25 cm . Fruit clusters are very susceptible to infection by powdery mildew from bloom to 4–6 weeks postbloom. Unless otherwise indicated, spray at 7–10-day intervals to protect developing fruit clusters. Spray at 7-day intervals if weather is conducive to disease, unless otherwise specified on label.		

Disease or Insect	Product (Group)	Rate	Comments
Botrytis bunch rot	• Rovral WDG (2)	1.5 kg/ha	If the bloom/postbloom period is wet, spray immediately to control latent infections in susceptible varieties (Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Gewurztraminer, Sauvignon Blanc and Seyval Blanc). Direct this spray at the fruiting zone. Rovral, Luna Tranquility, Vanguard, Scala, Pristine, Switch, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain. Pristine, Serenade MAX, Regalia Maxx: Suppression only, see Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242. Regalia Maxx: Apply before symptoms develop. Use 0.25% (1.25 L in 500 L water) in rotation with other fungicides.
	• Luna Tranquility (7+9)	1.2 L/ha	
	• Vanguard 75 WG (9)	750 g/ha	
	• Scala SC (9)	2 L/ha	
	• Pristine WG (7+11)	420–735 g/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
	• Elevate 50 WDG (17)	1.12 kg/ha	
	• Serenade MAX (44)	3–6 kg/ha	
	• Regalia Maxx (P5)	0.25% v/v in 500 L water	
Immediate postbloom to early fruit set			
Mealy bug	• Movento 240 SC (23)	365–585 mL/ha	If grapevine leafroll virus has been confirmed by an accredited lab and mealy bugs have been confirmed in the vineyard, this spray may reduce mealy bug pressure and spread of grapevine leafroll virus. Will redistribute to young leaves as they develop. Re-apply 30 days later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v (2 L/1,000 L water). See label for further details. Surfactants may remove the waxy bloom on grape berries.
Leafhoppers	Use one of the products listed for leafhoppers at Immediate prebloom .		
Phylloxera (leaf form)	Use one of the products listed for phylloxera at Immediate prebloom .		
Japanese beetle	Use one of the products listed for Japanese beetle at Immediate prebloom .		
Black rot	Use one of the products listed for black rot at Shoot length 20–25 cm . Fruit clusters are highly susceptible to black rot from bloom to 4 weeks postbloom. Apply at 7–10-day intervals to protect expanding leaves and developing fruit clusters. Apply at shorter intervals if weather is conducive to disease unless otherwise specified on label.		
Powdery mildew	Use one of the products listed for powdery mildew at Shoot length 20–25 cm . Fruit clusters are highly susceptible to powdery mildew from bloom to 4–6 weeks postbloom. Unless otherwise indicated, spray at 7–10-day intervals to protect developing fruit clusters. Spray at 7-day intervals if weather is conducive to disease unless otherwise specified on label.		
Downy mildew	Use one of the products listed for downy mildew at Trace bloom . Fruit clusters are highly susceptible to downy mildew until 4–6 weeks after bloom. Unless otherwise indicated, spray at 7–10-day intervals to protect developing fruit clusters. Spray at 7-day intervals if weather is conducive to unless otherwise specified on label.		
Botrytis bunch rot	Use one of the products listed for botrytis bunch rot at Trace bloom . If the bloom or postbloom period is wet, an immediate postbloom spray may provide control of latent infections in varieties prone to botrytis bunch rot (e.g., Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Gewurztraminer, Sauvignon Blanc and Seyval Blanc). Direct spray at the fruiting zone.		
Berries pea-sized			
Grape berry moth (Second generation)	• Imidan 70-WP Instapak (1)	2.2 kg/ha	Where mating disruption is in place and monitoring indicates good control, an insecticide is not needed at this time. Where there is a history of damage, use one of these products. Re-apply if flight is extended. Direct spray at the fruiting zone. Imidan: Be aware of current label changes with respect to rates, restrictions and precautions. See Table 5-4. <i>Products Used on Grapes</i> , page 153. Delegate, Success, Entrust: Suppression only, see Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Delegate, Success, Entrust, Intrepid, Altacor: Apply at first egg hatch (first sustained moth catch in pheromone traps), earlier than the traditional timing (upswing in moth numbers captured in traps) used for Group 3 insecticides or Imidan. A second application may be necessary if flight is extended. Dipel, BioProtec: Re-apply 7–10 days later, if needed.
	• Pounce 384 EC (3)	360 mL/ha	
	• or Perm-Up (3)	360 mL/ha	
	• or Ambush 500 EC (3)	275 mL/ha	
	• Up-Cyde 2.5 EC (3)	240 mL/ha	
	• Delegate WG (5)	280 g/ha	
	• Success (5)	182 mL/ha	
	• or Entrust SC (5)	364 mL/ha	
	• Dipel 2X DF (11)	1.125 kg/ha	
	• or BioProtec CAF (11)	2.8 L/ha	
	• Intrepid 240 F (18)	600 mL/ha	
	• Altacor (28)	285 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Japanese beetle	Use one of the products listed for Japanese beetle at Immediate prebloom .		
Grape phylloxera (leaf form)	Use one of the products listed for Phylloxera at Immediate prebloom .		
Powdery mildew	Use one of the products listed for powdery mildew at Shoot length 20–25 cm . Fruit clusters are highly susceptible to powdery mildew from bloom to 4–6 weeks postbloom. Unless otherwise indicated, spray at 7–10-day intervals to protect developing fruit clusters. Spray at 7-day intervals if weather is conducive to disease. Increase rate of Microscopic Sulphur to 6 kg/1,000 L water. Purespray Green Spray Oil may remove the waxy bloom on grape berries.		
Downy mildew	Use one of the products listed for downy mildew at Trace bloom . Fruit clusters are highly susceptible to downy mildew until 4–6 weeks after bloom. Unless otherwise indicated, spray at 7–10-day intervals to protect developing fruit clusters. Spray at 7-day intervals if weather is conducive to disease		
Black rot	Use one of the products listed for black rot at Shoot length 20–25 cm . Fruit clusters are highly susceptible to black rot from bloom to 4 weeks postbloom.		
Berry touch to cluster closure			
Check product labels and Table 5-4. <i>Products Used on Grapes</i> , page 153, for preharvest intervals.			
Mealy bug	Use one of the products listed for mealy bug at Immediate postbloom to early fruit set .		
Powdery mildew	Use one of the products listed for powdery mildew at Shoot length 20–25 cm . Fruit clusters are highly susceptible to powdery mildew from bloom to 4–6 weeks postbloom. Increase rate of Microscopic Sulphur to 6 kg/1,000 L water. Purespray Green Spray Oil may remove the waxy bloom on grape berries.		
Downy mildew	Use one of the products listed for downy mildew at Trace bloom . Fruit clusters are highly susceptible to downy mildew until 4–6 weeks after bloom.		
Black rot	Use one of the products listed for black rot at Shoot length 20–25 cm . This spray is necessary only if black rot is severe and new infections continue to occur.		
Botrytis bunch rot	Use one of the products listed for botrytis bunch rot at Trace bloom . Many of the vinifera and French hybrid varieties with tight clusters are susceptible to botrytis bunch rot (e.g., Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Gewurztraminer, Sauvignon Blanc and Seyval Blanc). Direct spray at the fruiting zone. Ensure complete coverage of berries before clusters close. Do not use Rovral after berry touch.		
European red mite	• Agri-Mek 1.9% EC (6) • Nexter (21) • Envidor 240 SC (23) • Acramite 50 WS (UN)	585–1,170 mL/ha 300 g/ha 750 mL/ha 851 g/ha	Apply if significant bronzing of mid-shoot leaves occurs. Stressed vines will show injury earlier than healthy vines. Monitor 7–10 days after application to evaluate control. Re-apply 21 days later, if needed. Agri-Mek: Use 585–875 mL/ha for low to moderate infestations and 1,170 mL/ha for severe infestations. Apply when mites first appear. Use with a non-ionic surfactant in a minimum of 470 L of water/ha. Do not apply within 10 days of Captan, Maestro or Folpan fungicides. Nexter: Effective against nymphs only. Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Beginning of ripening (veraison) through harvest			
Check product labels and Table 5-4. <i>Products Used on Grapes</i> , page 153, for preharvest intervals.			
Grape berry moth (about mid to late August)	In blocks without mating disruption, use one of the products listed for grape berry moth at Berries pea-sized . Border sprays of conventional insecticides may be very effective. Direct spray at fruiting zone. Where mating disruption for GBM is in place and monitoring indicates good control, an insecticide may not be needed at this time.		
Powdery mildew	Use one of the products listed for powdery mildew at Shoot length 20–25 cm . Foliage of vinifera and some French hybrid varieties are more susceptible and may require extra sprays. Increase rate of Microscopic Sulphur to 6 kg/1,000 L water. Purespray Green Spray Oil may remove the waxy bloom on grape berries.		
Downy mildew	Use one of the products listed for downy mildew at Trace bloom . Foliage of vinifera and some French hybrid varieties are more susceptible and may require extra sprays.		
Slugs and snails	• Sluggo Professional (NC)	25 kg/ha	Apply 50 kg/ha if population is very high. Apply when infestation begins. Re-apply as the bait is consumed or at least every 2 weeks if slugs and snails continue to be a problem.

Disease or Insect	Product (Group)	Rate	Comments
Special sprays (when monitoring indicates the need)			
Botrytis bunch rot	• Luna Tranquility (7+9)	1.2 L/ha	This spray is necessary for tight-clustered, thin-skinned varieties. If conditions are warm and wet through the preharvest period, a second spray may be needed. Direct this spray to the fruiting zone. Luna Tranquility, Vanguard, Scala, Pristine, Switch, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain. Pristine, Serenade MAX, Regalia Maxx: Suppression only, see Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. Regalia Maxx: Apply before symptoms develop. Use 0.25% (1.25 L in 500 L water) in rotation with other fungicides.
	• Vanguard 75 WG (9)	750 g/ha	
	• Scala SC (9)	2 L/ha	
	• Pristine WG (7+11)	420–735 g/ha	
	• Switch 62.5 WG (9+12)	775–975 g/ha	
	• Elevate 50 WDG (17)	1.12 kg/ha	
	• Serenade MAX (44)	3–6 kg/ha	
Multicoloured Asian lady beetle	• Regalia Maxx (P5) water	0.25% v/v in 500 L	Lady beetles are not a problem until very close to harvest. Begin monitoring around mid-August and continue for each cultivar until harvested. Early presence of lady beetles is not an immediate concern because they can arrive and leave an area rapidly. Discuss beetle thresholds and product restrictions with the proposed purchaser of grapes before taking action. Continue to monitor after treatment; re-infestation may occur before harvest. Ripcord: Cannot be used on juice grapes destined for export to the United States. Do not use on table grapes.
	• Malathion 85 E (1)	880 mL/ha	
	• Ripcord (3)	150 mL/ha	
Yellow jacket wasps	• Ripcord (3)	150 mL/ha	Cannot be used on juice grapes destined for export to the United States. Do not use on table grapes.
Brown marmorated stink bug	• Malathion 85 E (1)	880 mL/ha	At time of printing this publication, this pest has not been detected in vineyards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply when insects first appear. Malathion, Clutch: Suppression only, see Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
	• Clutch 50 WDG (4)	210 g/ha	

Preharvest Intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 5-4. *Products Used on Grapes*, page 153, are taken from product labels. In some cases, regulations on residues in finished products are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the grape purchaser for more details.

Table 5-4. Products Used on Grapes

Use this table as a guide, but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per year (on label)
Products used to control or suppress of insects and mites						
Acramite 50 WS	27925	bifenazate	UN	14 days	12 hours ¹ /24 hours ²	1
Admire 240 F	24094	imidacloprid	4A	0 days	24 hours	2
Agri-Mek 1.9% EC	24551	abamectin	6	28 days	12 hours ¹ /13 days ²	2
Altacor	28981	chlorantraniliprole	28	14 days	12 hours	3 (max. 645 g/ha)
Ambush 500 EC	14882	permethrin	3	7 days	12 hours	—
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /5 days ²	2
BioProtec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	6
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	1 day	12 hours	2
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	6
Entrust SC	30382	spinosad	5	7 days	when dried ¹ /7 days ²	3
Envior 240 SC	28051	spirodiclofen	23	14 days	12 hours	1
Imidan 70-WP Instapak	29064	phosmet	1B	14 days	14 days ¹ /30 days ²	3
Intrepid 240 F	27786	methoxyfenozide	18	30 days	12 hours	3
Malathion 85 E	8372	malathion	1B	3 days	12 hours ¹ /72 hours ²	1
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	2 (max. 920 mL/ha)
Nexter	25135	pyridaben	21	25 days	24 hours	1
Perm-Up	28877	permethrin	3	21 days	12 hours	—
Pounce 384 EC	16688	permethrin	3	21 days	when dried	2
Pyganic EC 1.4II	30164	pyrethrins	3	—	12 hours	8
Ripcord	30316	cypermethrin	3	2 days/7 days ³	12 hours	3/2 ⁴
Sevin XLR	27876	carbaryl	1A	5 days ⁵	12 hours	—

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. P = Plant extract.

U/UN = Mode of action has not been determined. — = Information is not specified on the product label.

¹ General re-entry.

² Hand labour (e.g., training, thinning, leaf pulling, hand harvest).

³ Preharvest interval is 2 days for mechanical harvest or 7 days for hand harvest.

⁴ Maximum 3 applications per year for mechanical harvest or 2 applications for hand harvest.

⁵ Check with processor and winery for wine grapes.

⁶ Preharvest interval is 1 day for table grapes or 21 days for wine grapes.

⁷ Maximum 2 applications at botrytis rate or 3 applications at powdery mildew rate.

⁸ Preharvest interval is 14 days for table grapes.

Table 5-4. Products Used on Grapes (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per year (on label)
Sluggo Professional	30025	ferric phosphate	NC	—	12 hours	—
Success	26835	spinosad	5	7 days	when dried ¹ /7 days ²	3
Surround WP	27469	kaolin	NC	0 days	12 hours	—
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Products used for control or suppression of diseases						
Acrobat 50 WP	27700	dimethomorph	40	14 days	12 hours ¹ /12 days ²	4
Aliette	27688	fosetyl-al	33	15 days	6 days	7
Buran	30601	garlic powder	NC	0 days	when dried	—
Cantus WDG	30141	boscalid	7	14 days	12 hours	5
Confine Extra	30648	mono- and di-basic salts of phosphorus acid	33	1 day	12 hours	9
Copper 53W	9934	basic copper sulphate	M	1 day ³	48 hours	7
Copper Spray	19146	copper oxychloride	M	1 day ³	48 hours	7
Elevate 50 WDG	25900	fenhexamid	17	7 days	4 hours	3
Ferbam 76 WDG	20136	ferbam	M	7 days	12 hours	—
Flint	30619	trifloxystrobin	11	14 days	12 hours ¹ /5 days ²	4
Folpan 80 WDG	27733	folpet	M	1 day	24 hours	2
Gavel 75 DF	26842	zoxamide + mancozeb	22+M	66 days	48 hours	6
Guardman Copper Oxychloride 50	13245	copper oxychloride	M	1 day ³	48 hours	7
Inspire	30004	difenoconazole	3	7 days	12 hours ¹ /48 hours ²	7 (max. 2.04 L/ha)
Kocide 2000	27348	copper hydroxide	M	1 day ³	48 hours	7
Kumulus DF	18836	sulphur	M	1 day/21 days ⁶	24 hours	8
Luna Tranquility	30510	fluopyram + pyrimethanil	7+9	7 days	12 hours ¹ /24 hours ²	2/3 ⁷
Maestro 80 DF	26408	captan	M	7 days	72 hours	—
Manzate Pro-Stick	28217	mancozeb	M	30 days	24 hours	4
Mettler 125 ME	30673	tetraconazole	3	15 days	12 hours ¹ /15 days ²	2
Microscopic Sulphur	14653	sulphur	M	1 day/21 days ⁶	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day/21 days ⁶	24 hours	8
MilStop	28095	potassium bicarbonate	NC	0 days	4 hours	10
Nova 40 W	22399	myclobutanil	3	14 days	12 hours ¹ /12 days ²	5
Penncozeb 75 DF Raincoat	30241	mancozeb	M	30 days	24 hours	4
Phostrol	30449	mono- and di-basic sodium, potassium and ammonium phosphites	33	0 day	12 hours	4
Polyram DF	20087	metiram	M	45 days	12 hours	3
Presidio	30051	fluopicolide	43	21 days	12 hours ¹ /8 days ²	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. P = Plant extract.

U/UN = Mode of action has not been determined. — = Information is not specified on the product label.

¹ General re-entry.² Hand labour (e.g., training, thinning, leaf pulling, hand harvest).³ Preharvest interval is 2 days for mechanical harvest or 7 days for hand harvest.⁴ Maximum 3 applications per year for mechanical harvest or 2 applications for hand harvest.⁵ Check with processor and winery for wine grapes.⁶ Preharvest interval is 1 day for table grapes or 21 days for wine grapes.⁷ Maximum 2 applications at botrytis rate or 3 applications at powdery mildew rate.⁸ Preharvest interval is 14 days for table grapes.

Table 5-4. Products Used on Grapes (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per year (on label)
Pristine WG	27985	boscalid + pyraclostrobin	7+11	14 days	when dried ¹ / 21 days ²	6
Purespray Green Spray Oil 13E	27666	mineral oil	NC	14 days ^{3,8}	12 hours	—
Quintec	29755	quinoxifen	13	14 days	12 hours	5
Rampart	30654	mono and dipotassium salts of phosphorous acid	33	1 day	4 hours	5
Regalia Maxx	30199	extract of <i>Reynoutria sachalinensis</i>	P5	0 days	when dried	—
Revus	29074	mandipropamid	40	14 days	12 hours	4
Ridomil Gold MZ 68 WG	28893	metalaxyl + mancozeb	4+M	66 days	24 hours	1 (prebloom) 1 (postbloom)
Rovral WDG	24709	iprodione	2	before bunch closure ⁵	12 hours	2
Scala SC	28011	pyrimethanil	9	7 days	12 hours ¹ /24 hours ²	3
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Sirocco	31091	potassium bicarbonate	NC	0 days	4 hours	10
Sovran	26257	kresoxim-methyl	11	14 days	48 hours	4
Supra Captan 80 WDG	24613	captan	M	7 days	72 hours	—
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	7 days	12 hours ¹ /48 hours ²	2
Tivano	30468	citric acid + lactic acid	NC	—	when dried	—
Vanguard 75 WG	25509	cyprodinil	9	7 days	48 hours	2
Vivando SC	29765	metrafenone	U8	14 days	12 hours	6
Zampro	30321	ametoctradin + dimethomorph	40+45	14 days	12 hours ¹ /12 days ²	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. P = Plant extract.

U/UN = Mode of action has not been determined. — = Information is not specified on the product label.

¹ General re-entry.

² Hand labour (e.g., training, thinning, leaf pulling, hand harvest).

³ Preharvest interval is 2 days for mechanical harvest or 7 days for hand harvest.

⁴ Maximum 3 applications per year for mechanical harvest or 2 applications for hand harvest.

⁵ Check with processor and winery for wine grapes.

⁶ Preharvest interval is 1 day for table grapes or 21 days for wine grapes.

⁷ Maximum 2 applications at botrytis rate or 3 applications at powdery mildew rate.

⁸ Preharvest interval is 14 days for table grapes.

Notes on Grape Pests

Table 5-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 156, provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, such as

extended cool weather, any given variety may be more seriously affected.

See Table 5-6. *Activity of Fungicides on Grape Diseases*, page 157 and Table 5-7. *Activity of Insecticides on Grape Insect Pests*, page 159 for effect of fungicides and insecticides, respectively, on grape pests.

Table 5-5. Relative Susceptibility of Grape Cultivars to Diseases^A

Cultivar	Phomopsis cane blight	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity
Vinifera wine^B						
Auxerrois	MS	MS	MS	HS	HS	—
Cabernet Franc	MS	HS	MS	HS	SS	—
Cabernet Sauvignon	MS	HS	MS	HS	SS	—
Chardonnay	MS	HS	ES	ES	HS	—
Gamay	SS	MS	MS	HS	MS	—
Gewurztraminer	SS	HS	MS	HS	HS	—
Merlot	SS	HS	MS	HS	MS	2
Pinot Blanc	UN	HS	MS	HS	HS	—
Pinot Gris	SS	HS	MS	HS	HS	—
Pinot Noir	SS	HS	MS	HS	HS	—
Riesling	SS	HS	MS	HS	HS	—
Sauvignon Blanc	SS	MS	MS	MS	HS	—
Zweigeltrebe	MS	HS	MS	HS	SS	—
French hybrid wine						
Baco Noir	MS	SS	SS	MS	HS	1
Chambourcin	SS	MS	MS	MS	SS	1
De Chaunac	HS	SS	SS	MS	SS	1
Marechal Foch	MS	SS	SS	MS	SS	1
Seyval Blanc	MS	MS	MS	HS	HS	—
S.V. 23-512	SS	SS	MS	MS	SS	—
Vidal 256	SS	SS	MS	MS	HS	2
American hybrid wine						
Frontenac	SS	MS	MS	SS	SS	—
Frontenac gris	SS	MS	MS	SS	SS	—
Juice and table wine^C						
Concord	MS	MS	MS	MS	SS	1,2,3
Elvira	HS	MS	SS	MS	MS	3
Fredonia	MS	MS	HS	MS	SS	—
Himrod	SS	MS	SS	MS	MS	—
Niagara	MS	HS	HS	MS	SS	2
N.Y. Muscat	SS	SS	SS	MS	SS	—
Sovereign Coronation	SS	SS	HS	HS	MS	—

UN = Relative susceptibility is unknown. SS = Slightly susceptible. MS = Moderately susceptible. HS = Highly susceptible. ES = Extremely susceptible.

^A These notes are based on grower experience and could vary under stress conditions.

^B Vinifera varieties not included in this chart are considered susceptible to powdery mildew, downy mildew and black rot.

^C All juice and table varieties are Labrusca species, with exception of Himrod (American hybrid).

1 = Sulphur-sensitive. 2 = Copper-sensitive. 3 = Flint- and Pristine-sensitive. — = No chemical sensitivity has been observed.

Table 5-6. Activity of Fungicides on Grape Diseases

Please see the product label or crop calendars for registered uses. Use fungicides only for the crop and disease combinations listed on the product label. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Fungicide	Anthraco	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot	Activity
M	Copper 53W	0	1 *	1 *	3 *	2	0	Contact
M	Copper Spray	0	1	1	2 *	2 *	0	Contact
M	Guardsman Copper Oxychloride 50	0	1 *	1	2 *	2 *	0	Contact
M	Kumulus DF	1	1	0	0	3 *	0	Contact
M	Microscopic Sulphur	1	1	0	0	3 *	0	Contact
M	Microthiol Disperss	1	1	0	0	3 *	0	Contact
M	Lime Sulphur	2	0	0	0	1 *	0	Contact
M	Ferbam 76 WDG	2	3	3 *	2	0	0	Contact
M	Polyram DF	2	3	3 *	3 *	0	0	Contact
M	Penncozeb 75 DF Raincoat	2	3	3 *	3 *	0	0	Contact
M	Manzate Pro-Stick	2	3	3 *	3 *	0	0	Contact
M	Supra Captan 80 WDG	2	3 *	1 *	3 *	0	0	Contact
M	Folpan 80 WDG	2	3 *	1 *	3 *	0	0	Contact
M	Maestro 80 DF	2	3 *	1 *	3 *	0	0	Contact
2	Rovral WDG	0	0	0	0	0	2 *	Local systemic
3	Inspire	3	0	3	0	3 *	0	Local systemic
3	Mettler 125ME	3	0	3 *	0	3 *	0	Local systemic
3	Nova 40 W	3 *	0	3 *	0	3 *	0	Local systemic
4	Ridomil Gold MZ 68 WG	0	1	1	3 *	0	0	Systemic
7	Cantus WDG	0	0	0	0	3 *	1	Local systemic
7+9	Luna Tranquility	0	0	0	0	3 *	3 *	Local systemic
9	Scala SC	0	0	0	0	0	3 *	Local systemic
9	Vanguard 75 WG	0	0	0	0	0	3 *	Local systemic
9+12	Switch 62.5 WG	0	0	0	0	0	3 *	Local systemic
11	Flint	0	1	3 *	1	3 *	1	Local systemic
11	Sovran	0	1	3 *	2 *	3 *	1	Local systemic
11+7	Pristine WG	3 *	1	3 *	3 *	3 *	1 *	Local systemic
13	Quintec	0	0	0	0	3 *	0	Local systemic
17	Elevate 50 WDG	0	0	0	0	1	3 *	Local systemic
22	Gavel 75DF	0	0	0	3 *	0	0	Contact
33	Aliette	0	0	0	3 *	0	0	Systemic

0 = Ineffective. 1 = Slightly effective/suppression, not recommended for very susceptible varieties or at critical stages of infection. 2 = Moderately effective. 3 = Very effective. — = No information is available. * (shaded area) = The disease is listed on the product label for control or suppression.

M = Multi-site fungicides. NC = Not classified by FRAC, or group not indicated on product label. P = Plant extract. U = Mode of action has not been determined.

Fungicide activity (adapted from NY and PA Pest Management Guidelines for Grapes):

Contact: stays on the surface of plant

Local systemic: moves into plant but does not move to other plant parts

Systemic: moves into plant and to unsprayed plant parts as they develop

Table 5-6. Activity of Fungicides on Grape Diseases (cont'd)

Group	Fungicide	Anthraxnose	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot	Activity
33	Confine Extra	0	0	0	3*	0	0	Systemic
33	Phostrol	0	0	0	3*	0	0	Systemic
33	Rampart	0	0	0	3*	0	0	Systemic
40	Revus	0	0	0	3*	0	0	Local systemic
40	Acrobat 50 WP	0	0	0	3*	0	0	Systemic
43	Presidio	0	0	0	3*	0	0	Local systemic
44	Serenade MAX	0	0	0	0	1*	2*	Contact
40+45	Zampro	0	0	0	3*	0	0	Systemic
NC	MilStop	0	0	0	0	2*	1	Contact
NC	Sirocco	0	0	0	0	2*	1	Contact
NC	Buran	0	0	0	0	—*	0	Contact
NC	Tivano	0	0	0	—*	0	0	Contact
NC	Purespray Green Spray Oil 13E	0	0	0	0	2*	0	Contact
P5	Regalia Maxx	0	0	0	0	1*	1*	Local systemic
U8	Vivando SC	0	0	0	0	3*	0	Local systemic

0 = Ineffective. 1 = Slightly effective/suppression, not recommended for very susceptible varieties or at critical stages of infection. 2 = Moderately effective. 3 = Very effective. — = No information is available. * (shaded area) = The disease is listed on the product label for control or suppression.

M = Multi-site fungicides. NC = Not classified by FRAC, or group not indicated on product label. P = Plant extract. U = Mode of action has not been determined.

Fungicide activity (adapted from NY and PA *Pest Management Guidelines for Grapes*):

Contact: stays on the surface of plant

Local systemic: moves into plant but does not move to other plant parts

Systemic: moves into plant and to unsprayed plant parts as they develop

Table 5-7. Activity of Insecticides on Grape Insect Pests

Use insecticides only for insects listed on the product label for the crop and for the insect. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Product name	Grape berry moth	Leafhoppers	Phylloxera	Japanese beetle	Erineum mite	MALB	Wasps	European red mite	Climbing cutworm	Flea beetle	Grape mealy bug
1A	Sevin XLR	1 *	2 *	—	1	—	—	—	—	—	—	—
1B	Imidan 70-WP Instapak	3 *	3	—	2 *	—	—	—	—	—	1	—
1B	Malathion 85 E	1	2 *	—	—	—	3 *	3	2 *	—	—	2 *
3	Ambush 500 EC	3 *	2 *	—	—	—	—	—	0	3	3	—
3	Perm-Up	3 *	2 *	—	2	—	—	—	0	3	3	—
3	Pounce 384 EC	3 *	2 *	—	2	—	—	—	0	3 *	3	—
3	Pyganic EC 1.4II	2	2 *	—	1	—	—	—	0	—	—	—
3	Ripcord	—	—	—	—	—	3 *	3 *	0	—	—	—
3	Up-Cyde	3 *	2 *	—	—	—	—	—	0	—	—	—
4A	Assail 70 WP	1 *	3 *	2 *	2 *	—	—	—	0	—	—	2
4A	Admire 240 F	—	3 *	2	—	—	—	—	0	—	—	2
4A	Clutch 50 WDG	—	3 *	2 *	—	—	—	—	0	—	2	2 *
4C	Closer SC	—	1 *	—	—	—	—	—	0	—	—	—
5	Delegate WG	3 *	—	—	—	—	—	—	0	3	2	—
5	Entrust SC	2 *	—	—	—	—	—	—	0	—	2	—
5	Success	2 *	—	—	—	—	—	—	0	—	2	—
6	Agri-Mek 1.9% EC	0	—	—	—	1	—	—	2 *	—	—	—
11	Dipel 2X DF	2 *	0	0	0	0	0	0	0	—	0	0
11	BioProtec CAF	2 *	0	0	0	0	0	0	0	—	0	0
18	Intrepid 240 F	3 *	—	—	—	—	—	—	0	—	—	—
21	Nexter	0	0	0	0	1	0	0	2 *	0	0	0
23	Envior 240 SC	0	0	0	0	—	0	0	3 *	0	0	—
23	Movento 240 SC	0	—	3 *	0	2	0	0	—	0	0	3 *
28	Altacor	3 *	—	—	1 *	0	—	—	0	3 *	—	—
NC	Surround WP	—	2 *	—	1	—	—	—	—	—	1	—
NC	Purespray Green Spray Oil 13E	0	—	—	—	1 *	0	0	2 *	—	—	2
NC	Kumulus DF	0	0	0	0	2 *	0	0	—	0	0	0
NC	Microthiol Dispers	0	0	0	0	2 *	0	0	—	0	0	0
UN	Acramite 50 WS	0	0	0	0	—	0	0	2 *	0	0	0

0 = Ineffective. 1 = Slightly effective/suppression, not recommended for very susceptible varieties or at critical stages of infection. 2 = Moderately effective. 3 = Very effective. — = No information is available.

NC = Not classified by IRAC, or group not indicated on product label. UN = Mode of action has not been determined.
* (shaded area) = The pest is listed on the product label for control or suppression.

Insecticide activity adapted from NY and PA Pest Management Guidelines for Grapes, Michigan State University recommendations and other sources.

GRAPE NOTES

6. Tender Fruit

Tender Fruit Nutrition

Test the soil a year in advance of planting fruit trees, or two years before planting if pH adjustment may be necessary. Some soil amendments do not move readily through the soil profile, but are needed to optimize orchard productivity. These materials include organic matter, phosphorus, potassium, and lime to adjust soil pH. The only opportunity to thoroughly incorporate these materials is before planting.

Manure for Orchards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and many macro- and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for years after application. Adjust additional organic and inorganic nitrogen applications accordingly. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth and delayed cold-hardening of the woody tissue, which may make trees more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid) or 35 tonnes/ha of hog manure (65 m³ liquid). Since the nutrient content of manure varies greatly, it should be tested before application. See *Manure nitrogen*, page 16.
- Broadcast manure and work into the soil in late fall or early spring before planting. Do not place manure around newly planted trees in late summer because of potential winter injury.
- Adjust the rate of nitrogen, phosphorus and potassium fertilizers applied according to the nutrient content of the manure. See Table 2-10. *Average Fertilizer Replacement Values for Manure*, page 16.

- For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen*, *Use manure responsibly*, and *Manure and food safety*, page 16.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, page 12.

In established orchards, sample soil in the tree row every 3 years to ensure the pH is satisfactory. If the pH drops below 5.6 on sandy soils or below 5.1 on clay loam soils, apply lime to the sod cover in the fall or before spring cultivation. The results will not be immediate because lime moves and reacts slowly in the soil.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient status of the trees. When used in conjunction with soil analysis, it provides good information for adjusting fertilizer rates. For more information on these tests, see *Plant tissue analysis*, page 10.

Nutrient uptake is affected by many orchard conditions and varies slightly from year to year, depending on the season. For optimum growth and fruit quality, all nutrients must be available in sufficient concentrations. See Table 6-1. *Nutrient Concentration Sufficiency Ranges for Tender Fruits*, page 162.

For leaf analysis to be most effective, sample the same trees each year. Use leaf analysis together with soil test results to make adjustments to the fertilizer program. Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required. See OMAF document *Leaf Analyses for Fruit Crop Nutrition* at www.ontario.ca/crops.

Table 6-1. Nutrient Concentration Sufficiency Ranges for Tender Fruits (mid-shoot leaves in late July)

Crop	Nitrogen (N)*	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Iron (Fe)	Boron (B)	Zinc (Zn)	Manganese (Mn)
	%					ppm			
Peach	3.4–4.1	0.15–0.4	2.3–3.5	1–2.5	0.35–0.6	25–200	20–60	15–100	20–200
Pear	2–2.6	0.15–0.4	1.2–2	1–2	0.25–0.5	25–200	20–60	15–100	20–200
Plum	2.4–3.2	0.15–0.4	1.5–3	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200
Cherry (Montmorency)	2.2–3	0.15–0.4	1.3–2.5	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Fertilizer for Tender Fruit

Fertilizer for non-bearing tender fruit

The best time to effectively incorporate nutrients such as phosphorus, potassium, boron and lime is before planting. Adequate nutrient levels in the topsoil for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. See Table 6-2.

Phosphorus and Potassium Soil Requirements Before Planting Peach, Pear, Plum or Cherry Trees on this page for information on fertilizer rates prior to planting. Along with the incorporation of organic matter, these fertility levels will sustain the tree in the juvenile years. On coarse-textured, infertile soils, use a starter solution at planting time such as 10-52-10 or 20-20-20. High nitrogen levels can result in excessive growth and incomplete tree hardening. Use cover crops to reduce late-season nitrogen levels in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and will check tree growth. On young trees, broadcast the fertilizer under the spread of the branches. Keep the fertilizer at least 15 cm from the trunk, since injury can occur if it is placed too close.

Fertilizer for bearing tender fruit trees

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, which include growth, fruit bud formation, fruit set and fruit size. Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In situations where fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also affect nitrogen requirements. Tree growth, fruit colour

Table 6-2. Phosphorus and Potassium Soil Requirements Before Planting Peach, Pear, Plum or Cherry Trees

Soil Phosphorus		Soil Potassium	
Soil test (ppm P)	Phosphate (P ₂ O ₅) required (kg/ha) [response]	Soil test (ppm K)	Potash (K ₂ O) required (kg/ha) [response]
0–3	80 [HR]	0–15	180 [HR]
4–5	60 [HR]	16–30	170 [HR]
6–7	50 [HR]	31–45	160 [HR]
8–9	40 [MR]	46–60	140 [HR]
10–12	20 [MR]	61–80	110 [HR]
13–15	0 [LR]	81–100	70 [MR]
16–20	0 [LR]	101–120	40 [MR]
21–25	0 [RR]	121–150	20 [MR]
26–30	0 [RR]	151–180	0 [LR]
31–40	0 [RR]	181–210	0 [LR]
41–50	0 [RR]	211–250	0 [RR]
51–60	0 [RR]	250 +	0 [NR]
61–80	0 [NR]		
80 +	0 [NR]		

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

For established fruit trees, use plant analysis to estimate requirements of nitrogen, phosphorus and potassium.

and storability are also important considerations. Because of complex interactions with nitrogen and quality and production, the best guide for nitrogen rates is leaf analysis.

For pear, peach, plum and cherry orchards where leaf analysis is not available, the following rates are considered normal. For each year of the tree's age, apply between 30–40 g of nitrogen. Thus, a 5-year-old tree in sod culture requires 150–200 g of nitrogen. See Table 6-3. *Actual Nitrogen Rates per Tree in Sod Culture*, page 163. The rate for cultivated orchards can be reduced by half as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require

more nitrogen per ha (not per tree) than trees on more vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase with tree age. Again leaf analysis is the most reliable guide. There are several forms of nitrogen available. Do not apply urea (46-0-0) to orchards with sod between the rows because urea must be incorporated to prevent loss by volatilization. For all tree fruits, do not exceed 200 kg actual nitrogen per ha per year, even in cases of severe deficiency. Late or excessive applications of nitrogen result in poor fruit colour and quality. Available nitrogen late in the season encourages the tree to grow instead of harden off, which potentially leads to winter injury. In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil and limit tree growth. In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds take up extra nitrogen, which helps to harden off trees and improve fruit quality. If pruning is to be severe, reduce nitrogen rates or eliminate it for a year. During dry springs, irrigate to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall. For fire blight-sensitive pear cultivars, use less than the maximum rate of nitrogen suggested.

Nitrogen placement and timing

Apply nitrogen fertilizer in early April. In cultivated orchards, broadcast nitrogen under the tree canopy. In sod orchards, place the nitrogen in a band under the drip line or in the herbicide strip. If there is evidence of fruit bud damage due to severe winter temperatures, it may be necessary to split nitrogen applications. Apply the first application in mid-April and the second, if necessary, after bloom in late May.

Foliar application of nitrogen

When weather or crop conditions create a need for additional nitrogen at a critical time, foliar applications of urea (46-0-0) have been successfully used on fruit trees. Late applications adversely affect fruit quality and winter survival of the tree.

Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. Make applications based on tree performance and leaf analysis.

Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With a few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if the sod needs this nutrient.

Table 6-3. Actual Nitrogen Rates per Tree in Sod Culture

Tree age (years)	Number of trees per ha (trees per ac)		
	400 (160)	500 (200)	600 (240)
	Actual nitrogen per tree (grams)		
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

If indicated by a soil test, apply phosphorus before planting an orchard when it can be thoroughly incorporated into the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for tree establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and resistance to disease, such as fire blight in pears. Excess potassium can lead to magnesium (Mg) deficiency, so avoid unnecessary application of potassium. Soil test values between 120–150 ppm are adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, the following rates are considered normal.

For trees 1–6 years of age regardless of density, apply 50 g K_2O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

For trees 7 years of age or older, apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide.

Potassium placement and timing

In early spring, apply potassium separately or combined with nitrogen. Some growers make fall applications

because of time constraints in the spring. Leaching during winter may cause the loss of some potassium. For this reason, apply in spring if possible. In orchards with sod between the rows, apply potash in a band around the drip line or in the herbicide strip.

Foliar application of potassium

In dry growing seasons, potassium is not readily available to the plant. Foliar applications of potassium may be used where potassium deficiency is confirmed by leaf analysis.

Magnesium (Mg)

Magnesium deficiency has become more evident in orchards, particularly when high rates of potassium are used. Magnesium deficiency can lead to premature drop of fruit.

As magnesium is a part of the chlorophyll molecule, trees deficient in magnesium have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium needs.

Foliar sprays of magnesium are effective to correct magnesium deficiency for the current year only. For longer term correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. See Table 6-4. *Magnesium Foliar Sprays*, page 165.

Do not mix pesticides with magnesium sulphate (Epsom salts) as foliar injury may result. Check the manufacturer's label in regard to the mixture of magnesium chelates with pesticides. Use only chelates recommended for foliar sprays. For long-term corrections, apply magnesium to the soil. The response is not immediate. On some soil types, a single early spring application of soil-applied magnesium is not sufficient and a second or third application the following spring may be required before the magnesium level in the tree improves. To be sure that fruit drop is not a problem during this period, apply foliar sprays for the first two years in addition to soil applications. For soil corrections, apply 5–7 kg per mature standard tree and 3–4 kg per mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. Apply in early spring in a band under the tree drip line. It contains potassium (K) and the rate of application depends on potash needs. No further potash is likely to be required, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application. If magnesium is being blended with the fertilizer, apply at least 80 kg

of available magnesium per ha when the fertilizer is spread. Use dolomitic limestone on acidic soils to raise the soil pH and to supply magnesium.

Calcium (Ca)

Lack of calcium is associated with fruit quality problems in pear and gummosis in European plums and prunes. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. Some formulations of calcium chloride (CaCl_2) result in poor fruit finish if applied too close to harvest. Excessive calcium can cause foliar damage. The product used is not as important as the total amount of actual calcium applied.

Use CaCl_2 (77% flakes) at 4 kg/1,000 L of water from early July to mid-August. Apply 3 sprays, 10–12 days apart. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays. Calcium sprays may injure foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather. Do not apply calcium formulations containing nitrogen after the end of July or fruit quality and storability may suffer. For all formulations, consult the label for rates and compatibility with pesticides.

Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. Micronutrients applied in excess can cause more damage than deficiencies. Leaf analysis is more effective than soil analysis to evaluate tree micronutrient status. For more information see *Micronutrients*, page 21.

Do not apply micronutrients to fruit crops unless leaf analysis confirms a deficiency.

Apply only the nutrient that is deficient and only in sufficient quantities to correct the problem.

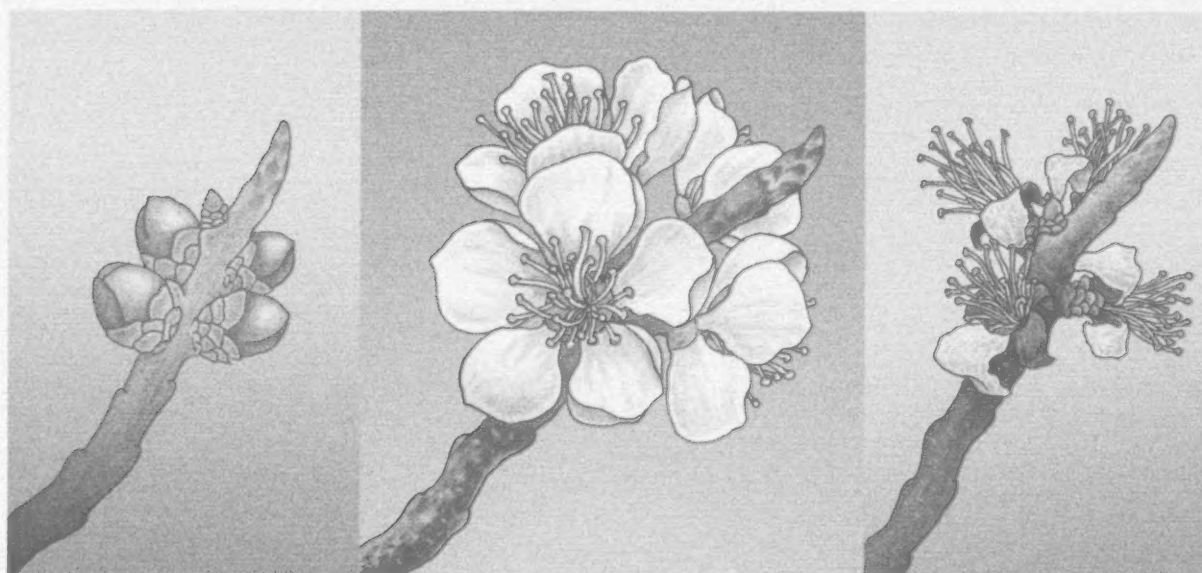
Apply nutrient sprays according to recommended rates on the product label. Do not spray during temperatures above 25°C.

Table 6-4. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at petal fall/shuck or shuck split	Magnesium sulphate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use only chelates recommended for foliar sprays.

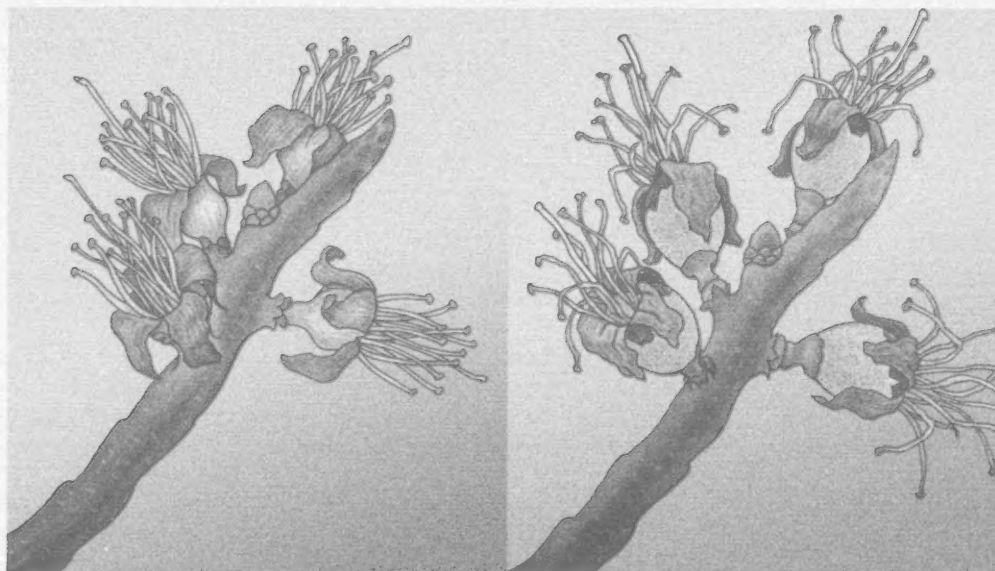
Figure 6-1. Apricot Growth Stages



Dormant

Bloom

Petal Fall



Shuck

Shuck Split

Apricot Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 6-5. *Products Used on Apricots*, page 170.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Topas, Indar, Jade, Mission, Fontelis, Cantus, Pristine, Rovral or Vangard when sporulating lesions of brown rot are present.

Insecticide resistance management

Take the following steps to avoid rapid development of insecticide resistance:

- For pests with discrete generations (oriental fruit moth, plum curculio and obliquebanded leafroller), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to apricots during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (In late March or early April before buds swell)			
European red mite	• Superior 70 Oil (NC)	20 L/1,000 L water	Apply in a high-volume spray to ensure thorough coverage. Do not apply Supra Captan or Maestro within 14 days of oil.
	• Purespray Green Spray Oil 13 E (NC)	20 L/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
Bloom			
DO NOT APPLY INSECTICIDES WHILE APRICOT TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Brown rot (blossom blight stage)	• Supra Captan 80 WDG (M) • Maestro 80 DF (M) • Rovral WDG (2) • Topas (3) • Jade (3) • Mission 418 EC (3) • Indar (3) • Cantus WDG (7) • Fontelis (7) • Pristine WG (7+11) • Vanguard 75 WG (9)	4.5 kg/ha 4.5 kg/ha 1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 1.0–1.75 L/ha 750 g/ha 370 g/ha	Apricots are extremely susceptible to brown rot. Spray when first blossoms open. If wet weather occurs repeat spray at 50% bloom and at full bloom. Rovral, Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Vanguard: These products are locally systemic. Consult labels for information on drying time required before rain.
Petal fall			
Brown rot	Use one of the fungicides listed for brown rot at Bloom .		
Scab	• Fontelis (7)	1.0–1.5 L/ha	Fungicides applied for brown rot may have some activity against scab. See Table 6-11. <i>Activity of Fungicides on Tender Fruit Diseases</i> , page 216.
Oriental fruit moth (OFM)	• Isomate-M Rosso • Isomate-M 100	500 dispensers/ha 250 dispensers/ha	Reduces mating of OFM. Apply dispensers before OFM flight begins. See <i>Mating Disruption in Fruit Crops</i> , page 250. Isomate-M 100: Provides mating disruption for up to 90 days. Re-apply 75–80 days after initial application, if necessary. Isomate-M Rosso: Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first-generation OFM (see Shuck split).
Shuck split (when about 50% of shucks have split)			
Brown rot	Use one of the fungicides listed for brown rot at Bloom . Apricots are extremely susceptible to brown rot from bloom through pit-hardening.		
Oriental fruit moth (OFM)	• Assail 70 WP (4) • Delegate WG (5) • Rimon 10 EC (15) • Intrepid 240 F (18) • Altacor (28) • Exirel (28)	120–240 g/ha 420 g/ha 1.35–3.35 L/ha 1.5 L/ha 285 g/ha 500–750 mL/ha	Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. For best results, apply within the specified degree-days (DDC, base 7.2°C) after sustained first-generation moth catch: Assail, Intrepid: Apply at 100–140 DDC. Rimon: Apply at 111–139 DDC. Delegate, Altacor, Exirel: Apply at 194–208 DDC. See Appendix B: <i>Degree-Day Modeling</i> , page 291. Re-apply 10–14 days later if trap catch is extended. Assail: For optimum activity, use the 240 g/ha rate in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Intrepid: Use for first generation only. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Some of these products are toxic to bees. Do not apply when bees are active in the orchard. Refer to label for specific bee toxicity statements.
Scab	Use one of the fungicides listed for scab at Petal fall .		
Plum curculio	• Sevin XLR (1) • Assail 70 WP (4) • Clutch 50 WDG (4) • Exirel (28)	6.25 L/ha 240 g/ha 210 g/ha 1.0–1.5 L/ha	Apricots are very susceptible to plum curculio injury. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg-laying scars. Damage often occurs only on the border of the orchard. Check developing fruit for new damage 7–10 days after insecticide is applied. Assail: Under high pressure, may provide suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Clutch: Applied at 420 g/ha may provide suppression of oriental fruit moth. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Shuck fall (10–12 days after last spray)			
Brown rot	Use one of the fungicides listed for brown rot at Bloom . Apricots are extremely susceptible to brown rot from bloom through pit-hardening.		
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck split . Monitor for plum curculio damage and spray if fresh damage is found.		
Scab	Use one of the fungicides listed for scab at Petal fall .		
First cover (10–12 days after Shuck fall)			
Brown rot	Use one of the fungicides listed for brown rot at Bloom . Apricots are extremely susceptible to brown rot from bloom through pit-hardening.		
Scab	Use one of the fungicides listed for scab at Petal fall .		
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck split .		
Special sprays (when monitoring indicates the need)			
Aphids	• Closer SC (4) • Beleaf 50 SG (9) • Exirel (28)	100–200 mL/ha 120–160 g/ha 0.75–1.5 L/ha	Closer: Use the higher rate for longer residual activity. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
European red mite	• Envidor 240 SC (23)	750 mL/ha	European red mite is a sporadic pest in apricot orchards. Apply when there are 10 active mites per leaf in the absence of beneficial predatory mites. Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Oriental fruit moth (OFM)	• Assail 70 WP (4) • Delegate WG (5) • Rimon 10 EC (15) • Altacor (28) • Exirel (28)	120–240 g/ha 420 g/ha 1.35–3.35 L/ha 285 g/ha 500–750 mL/ha	Check harvest dates of early varieties and do not spray within the preharvest interval. For best results, apply within the specified degree-days (DDC, base 7.2°C) after sustained first-generation moth catch: Assail: Apply at 583–611 DDC and again at 750–778 DDC. Delegate, Altacor, Exirel: Apply at 639–667 DDC and again at 805–833 DDC. Rimon: Apply at 555–583 DDC and again at 722–750 DDC. See Appendix B: <i>Degree-Day Modeling</i> , page 291. Assail: For optimum activity, use the 240 g/ha rate in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Obliquebanded leafroller (OBLR) Leafrollers	• Delegate WG (5) • Success (5) - or Entrust SC (5) • Dipel 2X DF (11) - or Bioprotec CAF (11) • Rimon 10 EC (15) • Altacor (28) • Exirel (28)	420 g/ha 182 mL/ha 364 mL/ha 1.125 kg/ha 4 L/ha 1.35–3.35 L/ha 285 g/ha 0.5–1.0 L/ha	Insecticides for OBLR summer generation should be applied at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch). Dipel, Bioprotec: Make 2 applications at 5–7-day intervals if activity of the larvae is extended. Work best if applied in the evening or on a cloudy day. See <i>Using Organic and Biopesticide Products</i> , page 242. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Lesser peachtree borer Peachtree borer	• Isomate-PTB Dual • Sevin XLR (1) • Thionex 50 WSP (2) • Rimon 10 EC (15)	350 dispensers/ha 6.25 L/ha 1.5 kg/1,000 L water 1.4 L/1,000 L water	Peachtree borers are sporadic pests of apricots. Isomate-PTB Dual: Reduces mating of peachtree and lesser peachtree borer. Apply before moth emergence begins, i.e., typically at or before shuck split. The dispensers are designed to last the entire season. In high-pressure sites, insecticides may be needed as long as the maximum labelled rate is not exceeded. See <i>Mating Disruption in Fruit Crops</i>, page 250. Use pheromone traps to monitor adult activity and begin sprays 1 week after first flight. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Sevin: For lesser peachtree borer only. Sevin, Thionex: Maximum of 3 applications per season at 5-10-day intervals. Rimon: Apply at 3-week intervals.
Brown marmorated stink bug	• Malathion 85E (1) • Clutch 50 WDG (4)	1.22 L/ha 210–420 g/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before populations reach damaging threshold. Malathion, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Prepick to harvest			
Check preharvest interval before spraying early maturing varieties. See Table 6-5. <i>Products Used on Apricots</i> , page 170.			
Brown rot	• Supra Captan 80 WDG (M) • Maestro 80 DF (M) • Topas (3) • Jade (3) • Mission 418 EC (3) • Indar (3) • Cantus WDG (7) • Fontelis (7) • Pristine WG (7+11) • Vanguard 75 WG (9)	4.5 kg/ha 4.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 1.0–1.75 L/ha 750 g/ha 740 g/ha	Apricots are extremely susceptible to brown rot just before picking. Topas, Jade, Mission: Maximum of 2 applications in the 3 weeks prior to harvest.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC (12)	496 mL/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

Table 6-5. Products Used on Apricots

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per year (on label)
Products used for control or suppression of insects and mites						
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /6 days ²	4
Beleaf 50 SG	29796	flonicamid	9C	14 days	12 hours ¹ /48 hours ²	3
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)
Delegate WG	28778	spinetoram	5	14 days	12 hours	3
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust SC	30382	spinosad	5	14 days	when dried	3
Envirdor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cytraniliprole	28	3 days	12 hours	4
Intrepid 240 F	27786	methoxyfenozide	18	7 days	12 hours	1 ³
Malathion 85 E	8372	malathion	1B	7 days	12 hours	2
Purespray Green Spray Oil 13E	27666	mineral oil	NC	—	12 hours	—
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	5 days	12 hours	—
Success	26835	spinosad	5	14 days	when dried	3
Superior 70 Oil	9542 14981	mineral oil	NC	prebloom only	12 hours	—
Thionex 50 WSP	29990	endosulfan	2A	18 days	7 days ¹ /20 days ²	3
Products used for control or suppression of diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Fontelis	30331	penthioopyrad	7	0 days	12 hours	max. 4.5 L/ha
Indar	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5 ⁴
Maestro 80 DF	26408	captan	M	2 days	48 hours	—
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5 ⁴
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	when dried ¹ / 24 hours ² /10 days ²	5
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	—
Topas	30163	propiconazole	3	3 days	72 hours	5 ⁴
Vanguard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

— = Information is not specified on the product label. M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label.

¹ General re-entry.

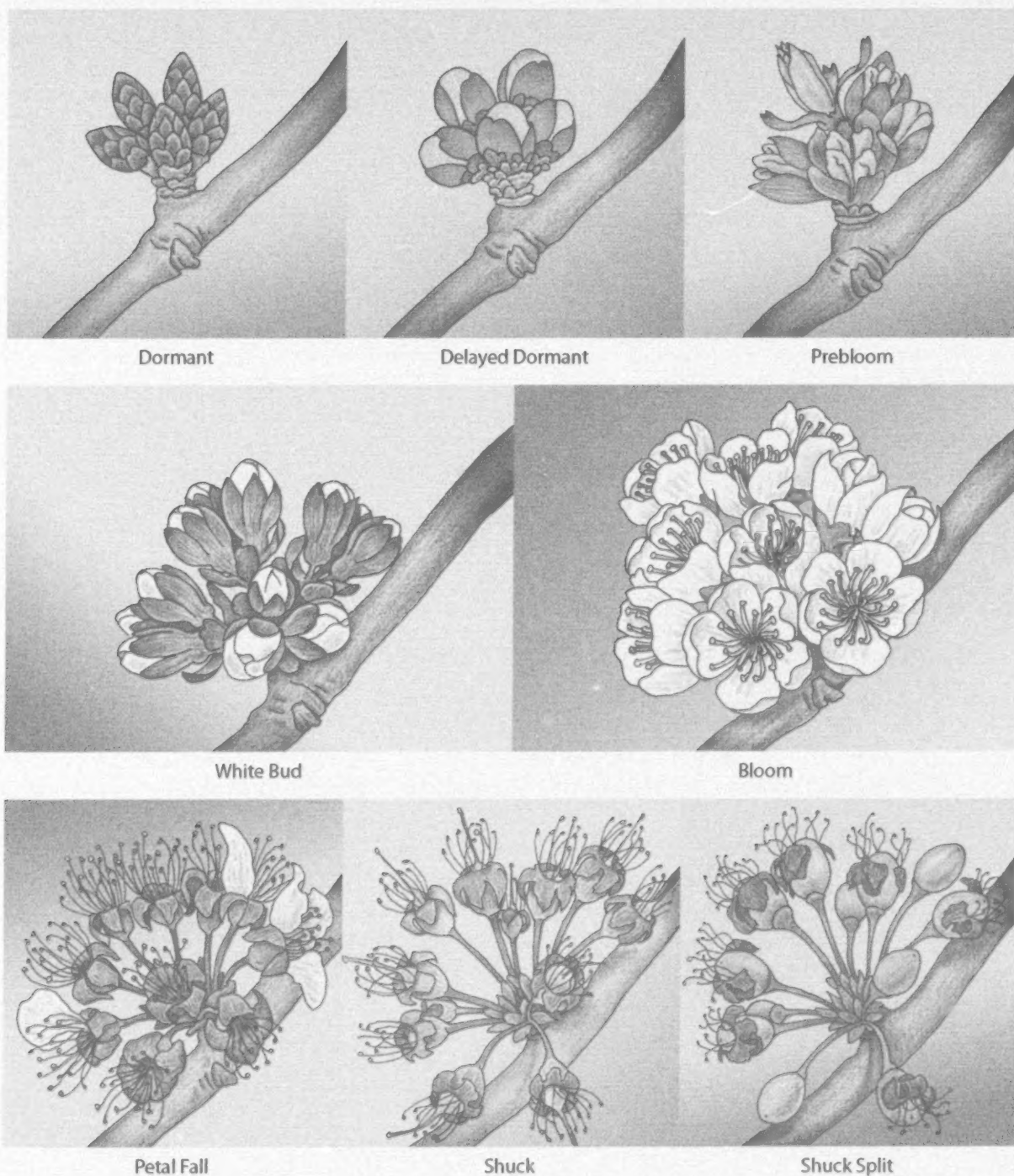
² Hand thinning.

³ Depends on rate. See label.

⁴ No more than 2 applications in the 3 weeks prior to harvest.

⁵ Hand harvest.

Figure 6-2. Sour and Sweet Cherry Growth Stages



Sour Cherry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period, and maximum number of applications, see Table 6-6. *Products Used on Sour Cherries*, page 177.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Nova, Topas, Indar, Jade, Funginex, Mission, Fontelis, Cantus, Pristine, Rovral, Elevate, Senator, Quintec, Cabrio, Equal or Flint when sporulating lesions of the target disease are present.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (plum curculio, obliquebanded leafroller), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites, cherry fruit fly), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to sour cherries during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (before bud break)			
Bacterial canker	- Copper Spray (M) - Guardsman Copper Oxychloride 50 (M)	6–9 kg/1,000 L water 6–9 kg/1,000 L water	Apply in early spring before bud break. Later applications may cause injury. Use low rate on small trees and high rate on large trees.
Black knot	Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards.		
Prebloom			
European red mite	- Superior 70 Oil (NC) - Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water 20 L/1,000 L water	Needed only in sour cherry orchards with a history of heavy mite populations. Spray as buds are breaking. Mature trees require water volumes of approximately 3,000 L/ha for thorough coverage.

Disease or Insect	Product (Group)	Rate	Comments
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Brown rot (blossom blight stage)	- Bravo 500 (M) or Echo 720 (M) - Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Kumulus DF (M) or Microthiol Disperss (M) - Senator 70 WP (1) - Rovral WDG (2) - Topas (3) or Jade (3) or Mission 418 EC (3) - Indar (3) - Funginex DC (3) - Nova 40 W (3) - Cantus WDG (7) - Fontelis (7) - Pristine WG (7+11) - Elevate 50 WDG (17)	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 22.5 kg/ha 22.5 kg/ha 1.75 kg/ha 1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 2.5 L/ha 340 g/ha 370 g/ha 1.0–1.75 L/ha 750 g/ha 1.7 kg/ha	Spray when first blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot than sweet cherries. One application during bloom should be sufficient, unless frequent wet periods occur and brown rot pressure is high. Bravo, Echo: Make 1–3 applications from white bud through shuck split. Use higher rate for trees greater than 6 m in height or if weather is warm (above 16°C) and wet during bloom. Captan, Maestro, Bravo, Echo: Do not use within 14 days of an oil application. Senator, Rovral, Topas, Jade, Mission, Funginex, Nova, Indar, Cantus, Fontelis, Pristine, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain. Topas, Jade, Mission: Also suppress black knot. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Petal fall			
Leaf spot	- Bravo 500 (M) or Echo 720 (M) - Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Ferbam 76 WDG (M) - Nova 40 W (3) - Topas (3) or Jade (3) or Mission 418 EC (3) - Fontelis (7) - Pristine WG (7+11) - Flint (11) - Equal 65 WP (U12)	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 1.75–2 kg/1,000 L water 340 g/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.5 L/ha 750 g/ha 210 g/ha 2.25 kg/ha	Spray only if rain is forecast between Bloom and Shuck split sprays. Bravo, Echo: Make 1 application for early season leaf spot. Nova, Topas, Jade, Mission, Pristine, Flint, Fontelis, Equal: These products are locally systemic. Consult labels for information on drying time required before rain. Fontelis: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Flint: Do not apply where spray drift may reach Concord grapes as it may cause crop injury.
Black knot	- Bravo 500 (M) or Echo 720 (M) - Indar (3) - Topas (3) or Jade (3) or Mission 418 EC (3)	7 L/ha 4.2–6.3 L/ha 140 g/ha 500 mL/ha 500 mL/ha 300 mL/ha	This spray is needed only on sour cherry orchards with a history of black knot. Topas, Jade, Mission, Indar: These products are locally systemic. Consult labels for information on drying time required before rain. Topas, Jade, Mission: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Shuck split			
Plum curculio	- Imidan 70-WP Instapak (1) - Silencer 120 EC (3) - Assail 70 WP (4) - Clutch 50 WDG (4) - Exirel (28)	2.68 kg/ha 104 mL/ha 240 g/ha 210 g/ha 1.0–1.5 L/ha	Spray when most shucks are off and plum curculio activity is observed. Silencer: Apply when the fruit is the size of a pea, and 10–12 days later if oviposition scars are detected. Silencer, Assail: Under high pressure, may provide suppression rather than control. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Brown rot	- Bravo 500 (M) or Echo 720 (M) - Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Rovral WDG (2) - Topas (3) or Jade (3) or Mission 418 EC (3) - Indar (3) - Cantus WDG (7) - Fontelis (7) - Pristine WG (7+11) - Elevate 50 WDG (17)	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 1.0–1.75 L/ha 750 g/ha 1.7 kg/ha	Bravo, Echo: Do not apply after shuck split to avoid fruit injury. Make 1–3 applications from white bud through shuck split. Use higher rate for trees greater than 6 m in height or if weather is warm (above 16°C) and wet during bloom. Rovral, Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain.
Leaf spot	Use one of the fungicides listed for leaf spot at Petal fall with the exception of Ferbam. Do not use Bravo or Echo after shuck split.		
European red mite	Nexter (21)	300 g/ha	Thorough coverage is necessary for good mite control. Needed only in heavily infested sour cherry orchards.
Black knot	Use one of the fungicides listed for black knot at Petal fall . This spray is needed only in sour cherry orchards with a history of black knot. Spore release may be delayed in dry springs. Under these conditions, extend fungicide coverage to First cover . Do not use Bravo or Echo after shuck split.		
First cover (12 days after shuck split)			
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck split . Monitor 7 days after the insecticide at Shuck split for new plum curculio damage. If new crescent-shaped cuts on fruit are found, apply an insecticide.		
Powdery mildew	- Kumulus DF (M) or Microthiol Disperss (M) - Nova 40 W (3) - Fontelis (7) - Flint (11) - Cabrio EG (11) - Pristine WG (7+11) - Quintec (13)	12 kg/ha 12 kg/ha 340 g/ha 1.0–1.75 L/ha 210 g/ha 670 g/ha 750 g/ha 500 mL/ha	Cover sprays applied after shuck split are critical for powdery mildew control. Flint: Do not apply where spray drift may reach Concord grapes. Pristine: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Obliquebanded leafroller (OBLR)	- Success (5) or Entrust SC (5) - Delegate WG (5) - Dipel 2X DF (11) or Bioprotec CAF (11) - Rimon 10 EC (15) - Intrepid 240 F (18) - Altacor (28) - Exirel (28)	182 mL/ha 364 mL/ha 420 g/ha 1.125 kg/ha 4 L/ha 1.35–3.35 L/ha 750 mL/ha 285 g/ha 0.5–1.0 L/ha	Routine monitoring is necessary to determine if OBLR is causing damage in sour cherries. Apply between 170–280 degree days (DDC, base 6.1°C) after sustained moth catch. Re-apply 10 days later if emergence is extended. Delegate, Rimon, Intrepid, Altacor: Apply at 240–280 DDC. Dipel, Bioprotec: Work best if applied in the evening or on a cloudy day. See <i>Using Organic and Biopesticide Products</i>, page 242. Exirel: Apply at first egg hatch, 170–240 DDC. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Leaf spot	Use one of the fungicides listed for leaf spot at Petal fall with the exception of Ferbam, Bravo or Echo.		

Disease or Insect	Product (Group)	Rate	Comments
Special sprays (when monitoring indicates the need)			
European red mite	• Envidor 240 SC (23)	750 mL/ha	Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Second cover (12 days after First cover)			
Cherry fruit fly	• Imidan 70-WP Instapak (1) • Diazinon 50 WSP (1) • Silencer 120 EC (3) • Admire 240 F (4) or Alias 240 SC (4) • Assail 70 WP (4) • GF-120 Fruit Fly Bait (5) • Entrust SC (5) • Altacor (28) • Exirel (28)	2.68 kg/ha 1 kg/1,000 L water 104 mL/ha 230 mL/ha 233 mL/ha 240 g/ha 1.5 L/ha 364 mL/ha 285 g/ha 0.75–1.5 L/ha	Diazinon, Imidan, Silencer, Exirel: On early varieties, check preharvest interval. Spray when early varieties are beginning to colour. A second application may be required 10 days later. GF-120: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. Will lose effectiveness if exposed to rain or overhead irrigation. See <i>Using Organic and Biopesticide Products</i> , page 242. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Use if needed for obliquebanded leafroller control. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck split .		
Obliquebanded leafroller	Routine monitoring is necessary to determine if obliquebanded leafrollers are causing damage in sour cherries. Use one of the insecticides listed for obliquebanded leafroller at First cover .		
Leaf spot	Use one of the fungicides listed for leaf spot at Petal fall with the exception of Ferbam, Bravo or Echo.		
Powdery mildew	Use one of the fungicides listed for powdery mildew at First cover .		
Third cover			
Check preharvest interval before spraying early maturing cherries. See Table 6-6. <i>Products Used on Sour Cherries</i> , page 177.			
Cherry fruit fly	Use one of the insecticides listed for cherry fruit fly at Second cover .		
Brown rot	Use one of the fungicides listed for brown rot at Shuck split .		
Leaf spot	Use one of the fungicides listed for leaf spot at Petal fall with the exception of Ferbam, Bravo and Echo.		
Special sprays (when monitoring indicates the need)			
European red mite	• Envidor 240 SC (23)	750 mL/ha	Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Preharvest			
Check preharvest interval before spraying early maturing cherries. See Table 6-6. <i>Products Used on Sour Cherries</i> , page 177.			
Brown rot	Use one of the fungicides listed for brown rot at Shuck split .		
Postharvest			
Leaf spot	• Bravo 500 (M) or Echo 720 (M) • Supra Captan 80 WDG (M) or Maestro 80 DF (M) • Nova 40 W (3) • Flint (11) • Pristine WG (7+11) • Equal 65 WP (U12)	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 340 g/ha 210 g/ha 750 g/ha 2.25 kg/ha	Necessary where leaf spot is a problem. Bravo, Echo: Apply once to foliage 1–7 days after fruit is removed. In orchards with high leaf spot incidence, re-apply 10–14 days later. Flint: Do not apply where spray drift may reach Concord grapes.
Powdery mildew	• Cabrio EG (11) • Pristine WG (7+11) • Quintec (13)	670 g/ha 750 g/ha 500 mL/ha	Pristine: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.

Disease or Insect	Product (Group)	Rate	Comments
Special sprays (when monitoring indicates the need)			
Aphids	• Diazinon 50 WSP (1)	1 kg/1,000 L water	These may be added to a compatible fungicide after bloom. Thorough coverage and a calm warm day are necessary for good aphid control. Diazinon, Closer: Registered for black cherry aphid only. Beleaf: Use high rate for high pressure and/or dense foliage. Movento: Most effective on young stages of aphids. Control may not be apparent for 2–3 weeks. Under high pressure, a second application may be necessary 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur.
	• Thionex 50 WSP (2)	3.25 kg/ha	
	• Clutch 50 WDG (4)	210 g/ha	
	• Admire 240 F (4)	230 mL/ha	
	• Closer SC (4)	100–200 mL/ha	
	• Beleaf 50 SG (9)	120–160 g/ha	
• Movento 240 SC (23)	365 mL/ha		
Peachtree borer Lesser peachtree borer	• Isomate-PTB Dual	350 dispensers/ha	Isomate-PTB Dual: Reduces mating of peachtree and lesser peachtree borer. Apply before moth emergence begins, i.e., typically at or before shuck split. Insecticides may be needed as long as the maximum labelled rate is not exceeded. See <i>Mating Disruption in Fruit Crops</i>, page 250. If mating disruption is not used, apply first spray 7 days after adult catch in pheromone trap. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the second and third sprays. Sevin: For lesser peachtree borer only. Sevin, Thionex: Apply at 5–10-day intervals. Rimon: Apply at 3-week intervals.
	• Sevin XLR (1)	6.25 L/ha	
	• Thionex 50 WSP (2)	1.5 kg/1,000 L water	
	• Rimon 10 EC (15)	1.4 L/1,000 L water	
Brown marmorated stink bug	• Malathion 85E (1)	880 mL/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before insect populations reach damaging threshold Malathion, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
	• Clutch 50 WDG (4)	210–420 g/ha	
Fall spray			
Bacterial canker	• Copper Spray (M)	6–9 kg/1,000 L water	Apply when three-quarters of leaves have fallen.
	• Guardsman Copper Oxychloride 50 (M)	6–9 kg/1,000 L water	

Table 6-6. Products Used on Sour Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	5
Alias 240 SC	28475	imidacloprid	4A	10 days	24 hours	5
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /6 days ²	4
Beleaf 50 SG	29796	flonicamid	9C	14 days	12 hours ¹ /48 hours ²	3
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	10 days	4 days	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust SC	30382	spinosad	5	7 days	when dried	4
Envirdor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4
GF-120 Fruit Fly Bait	28336	spinosad	5	0 days	when dried	10
Imidan 70-WP Instapak	29064	phosmet	1B	7 days	3 days ¹ */30 days ²	4
Intrepid 240 F	27786	methoxyfenozide	18	7 days	12 hours	2
Malathion 85 E	8372	malathion	1B	3 days	12 hours	2
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.12 L/ha
Nexter	25135	pyridaben	21	7 days	24 hours	1
Purespray Green Spray Oil 13E	27666	mineral oil	NC	prebloom	12 hours	—
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success	26835	spinosad	5	7 days	when dried	3
Superior 70 Oil	9542	mineral oil	NC	prebloom	12 hours	—
Thionex 50 WSP	29990	endosulfan	2A	18 days	7 days ¹ /20 days ²	1/3 ⁴

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pruning.

⁴ Maximum 1 application per year with airblast sprayer for aphids or or 3 applications per year with hand-held equipment for borer.

⁵ Before shuck fall.

⁶ Depends on rate. See label.

⁷ No more than 2 applications in the 3 weeks prior to harvest.

⁸ Preharvest interval is 0 days for mechanical harvest or 1 day for hand harvest.

⁹ Hand harvest.

¹⁰ Personal protective equipment required for certain activities. See label.

Table 6-6. Products Used on Sour Cherries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of diseases						
Bravo 500	15723	chlorothalonil	M	40 days	48 hours	3 ¹
Cabrio EG	27323	pyraclostrobin	11	10 days	12 hours ¹ /9 days ^{2,3}	5
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper Spray	19146	copper oxychloride	M	1 day	48 hours	2
Echo 720	29355	chlorothalonil	M	40 days	48 hours	3 ¹
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Equal 65 WP	15608	dodine	U12	7 days	48 hours	2 ⁴
Ferbam 76 WDG	20136	ferbam	M	4 days	12 hours	—
Flint	30619	trifloxystrobin	11	1 day	12 hours ¹ /4 days ²	5
Fontelis	30331	pen thiopyrad	7	0 days	12 hours	max. 4.5 L/ha
Funginex DC	27686	triforine	3	prebloom	48 hours	3
Guardman Copper Oxychloride 50	13245	copper oxychloride	M	1 day	48 hours	2
Indar	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5 ²
Kumulus DF	18836	sulphur	M	1 day	24 hours	8
Maestro 80 DF	26408	captan	M	5 days	48 hours	—
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5 ²
Nova 40 W	22399	myclobutanil	3	1 day	when dried	6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days/1 day ⁸	when dried ¹ /24 hours ⁹ /10 days ²	5
Quintec	29755	quinoxifen	13	7 days	12 hours	5
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Supra Captan 80 WDG	24613	captan	M	5 days	48 hours	—
Topas	30163	propiconazole	3	3 days	72 hours	5 ²

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pruning.

⁴ Maximum 1 application per year with airblast sprayer for aphids or 3 applications per year with hand-held equipment for borer.

⁵ Before shuck fall.

⁶ Depends on rate. See label.

⁷ No more than 2 applications in the 3 weeks prior to harvest.

⁸ Preharvest interval is 0 days for mechanical harvest or 1 day for hand harvest.

⁹ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Growth Regulators for Sour Cherries

Ethephon (Ethrel)

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity and to facilitate mechanical harvest.

The effectiveness of Ethrel treatment depends on several factors, including:

- **Temperature:** The response time of the tree to Ethrel application is shorter with higher temperatures. For this reason, apply Ethrel only in the temperature range of 18–30°C.

- **Tree vigour:** Tree vigour also affects the effectiveness of Ethrel treatment. Do not spray trees that have low vigour or are severely stressed by drought, disease or winter injury, which is indicated by gumming on the trunk and scaffold limbs. Treat only trees that are vigorous and in good health.
- **Rate:** Apply Ethrel at a rate of 2.75 L/ha (applied in approx. 2,400 L of water per ha). Fruit should be enlarging rapidly, with the grass-green colour beginning to turn yellow or developing a tinge of red. This generally coincides with 7–14 days before anticipated harvest. This rate helps to loosen fruit to facilitate mechanical harvesting. Consult the product manufacturer for further information.
- **Concentrate spraying:** Application of Ethrel in concentrate sprays (i.e., 1,000 L of water per ha or less) achieves the same level of loosening as dilute applications. Uniform coverage is important.
- **Tank-mixing:** There is little or no data regarding tank-mixing Ethrel. Do not tank-mix with foliar nutrients or compounds such as fruit-cracking inhibitors, etc. While no problems have been reported by growers for tank-mixing Ethrel with the fungicides and insecticides commonly used at this time, it is possible these materials may act as a buffer to the Ethrel and thereby alter activity.

Gibberellic acid (ProGibb 40 SB and Falgro)

To moderate early production, apply gibberellic acid (GA) in the fourth year. This allows flowering in year 5 at a reasonable level rather than allowing heavy bloom and production. Overproduction can significantly reduce growth in future years.

For mature Montmorency sour cherry trees infected with cherry yellows virus, apply GA annually. This helps maintain and extend high fruiting capacity and reduces occurrence of blind nodes through the stimulation of lateral shoots and spurs.

Apply about 3 weeks after full bloom, from shuck fall to 2 weeks after shuck fall. Use concentrations of 10–20 ppm (15 ppm is most common). Use lower rates on more vigorous trees. Gibberellic acid should not be applied to stressed trees. Apply the product as a fine mist. Maintain a neutral pH, below 8. Apply during slow drying conditions. Rates can vary depending on the age and vigour of the tree. For specific application instructions, which include rate and use of spreading agents, consult the product label. Do not harvest within 28 days of applying.

Prohexidione-calcium (Apogee)

Apogee can be used to reduce terminal growth in sour cherries. Reduction in terminal growth should help reduce the time required to dormant prune, as well as open up the tree canopy leading to improved spray coverage and reduced disease pressure. Limited research is available on the response of Montmorency sour cherries to Apogee.

- **Timing:** Terminal shoot growth in Ontario proceeds rapidly usually during the first 6 weeks of the season. Since 2 weeks are required for Apogee to slow growth effectively, it is essential to make the first application when terminal shoots are no longer than 2.5–5 cm. This typically coincides with late bloom, when sufficient leaf area has developed for Apogee to be translocated into the leaf. It reportedly has no detrimental effects on bees, so the first application can be made before bees are removed from the orchard.
- **Rate:** Apply Apogee at 1,350 g/ha when new terminal growth is 5–20 cm. If required, make a second application 14–21 days later (a maximum of 2 applications per season are permitted).
- **Tank-mixing:** Calcium sprays should not be tank-mixed with Apogee.
- **Other precautions:** A spray adjuvant (Agral 90, LI-700) should be included to improve plant uptake of Apogee. In addition, where a high calcium or magnesium water source (hard water) is used, it is important to include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee. Effects of Apogee on fruit set, fruit size and yield are inconsistent based on results reported in the literature. Several studies have reported a resurgence in late-season growth in some situations when marked suppression of growth was achieved early in the season. Furthermore, some resurgence in growth the year following application has been observed. Therefore, fine-tuning of treatment timings and concentrations may need to be considered.

Sweet Cherry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period and maximum number of applications, see Table 6-7. *Products Used on Sweet Cherries*, page 183.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Nova, Topas, Indar, Jade, Funginex, Mission, Fontelis, Cantus, Pristine, Rovral or Elevate when sporulating lesions of brown rot are present.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (plum curculio, obliquebanded leafroller), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites, cherry fruit fly), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to sweet cherries during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (before bud break)			
Bacterial canker	• Copper Spray (<i>M</i>)	6–9 kg/1,000 L water	Apply in early spring before bud break. Later applications in the spring may cause injury. Use low rate on small trees, and high rate on large trees.
	• Guardsman Copper Oxychloride 50 (<i>M</i>)	6–9 kg/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
White bud			
Brown rot (blossom blight stage)	• Rovral WDG (2)	1.75 kg/ha	These products are locally systemic and will penetrate petals to protect fruit from infection as bloom starts to occur. Consult labels for information on drying time required before rain.
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	
	• Nova 40 W (3)	340 g/ha	
	• Indar (3)	140 g/ha	
	• Funginex DC (3)	2.5 L/ha	
	• Cantus WDG (7)	370 g/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
• Pristine WG (7+11)	750 g/ha		
• Elevate 50 WDG (17)	1.7 kg/ha		
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Brown rot (blossom blight stage)	• Bravo 500 (M)	7 L/ha	Blossom blight is favoured by wet, warm (above 16°C) weather, especially when large numbers of mummies are present in the trees. Apply sprays during the bloom period if weather remains favourable for an extended blight or bloom period. Bravo: Do not apply after shuck to avoid fruit injury. Captan, Maestro, Bravo: Do not use within 14 days of oil. Rovral, Topas, Jade, Mission, Nova, Indar, Funginex, Cantus, Fontelis, Pristine, Elevate: These products are locally systemic and will penetrate petals to protect fruit from infection as bloom starts to occur. Consult labels for information on drying time required before rain.
	• Supra Captan 80 WDG (M)	4.5 kg/ha	
	• or Maestro 80 DF (M)	4.5 kg/ha	
	• Senator 70 WP (1)	1.75 kg/ha	
	• Rovral WDG (2)	1.75 kg/ha	
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	
	• Nova 40 W (3)	340 g/ha	
	• Indar (3)	140 g/ha	
	• Funginex DC (3)	2.5 L/ha	
	• Cantus WDG (7)	370 g/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
	• Pristine WG (7+11)	750 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	
Petal fall			
Black cherry aphid	• Diazinon 50 WSP (1)	1 kg/1,000 L water	Diazinon, Thionex: A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually 1–2 sprays are required. Clutch: Apply before populations reach threshold. Movento: Most effective on young stages of aphids. Control may not be apparent for 2–3 weeks. Under high pressure, a second application may be necessary 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur.
	• Thionex 50 WSP (2)	4.5 kg/ha	
	• Clutch 50 WDG (4)	210 g/ha	
	• Actara 25 WG (4)	160 g/ha	
	• Movento 240 SC (23)	365 mL/ha	
Shuck fall			
Plum curculio	• Silencer 120 EC (3)	104 mL/ha	Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C. Silencer: Apply when the fruit is the size of a pea, and 10–12 days later if oviposition scars are detected. Efficacious under low pressure only. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Assail 70 WP (4)	240 g/ha	
	• Clutch 50 WDG (4)	210 g/ha	
	• Exirel (28)	1.0–1.5 L/ha	
Brown rot	• Supra Captan 80 WDG (M)	4.5 kg/ha	Captan and Maestro: May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. Rovral, Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain.
	• or Maestro 80 DF (M)	4.5 kg/ha	
	• Rovral WDG (2)	1.75 kg/ha	
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	
	• Indar (3)	140 g/ha	
	• Cantus WDG (7)	370 g/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
	• Pristine WG (7+11)	750 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	

Disease or Insect	Product (Group)	Rate	Comments
First cover (12 days after Shuck fall)			
Plum curculio	Use one of the insecticides listed under Shuck fall . Monitor 7 days after shuck fall insecticide application for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.		
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall .		
Second cover (12 days after First cover)			
Cherry fruit fly	• Sevin XLR (1) • Diazinon 50 WSP (1) • Silencer 120 EC (3) • Admire 240 F (4) or Alias 240 SC (4) • GF-120 Fruit Fly Bait (5) • Entrust SC (5) • Altacor (28) • Exirel (28)	6.25 L/ha 1 kg/1,000 L water 104 mL/ha 230 mL/ha 233 mL/ha 1.5 L/ha 364 mL/ha 285 g/ha 0.75–1.5 L/ha	Sevin: Provides 5–7 days residual activity. Diazinon: On early varieties, check the preharvest interval. Spray when early varieties are beginning to colour. Provides 10 day residual activity. Admire: Apply as a foliar spray within 6 days of first fly emergence. Allow at least 10 days between applications. GF-120: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. Will lose effectiveness if exposed to rain or overhead irrigation. See <i>Using Organic and Biopesticide Products</i> page 242. Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Plum curculio	• Assail 70 WP (4) • Clutch 50 WDG (4) • Exirel (28)	240 g/ha 210 g/ha 1.0–1.5 L/ha	Monitor 7 days after previous insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall .		
Third cover			
Check preharvest interval before spraying early maturing cherries. See Table 6-7. <i>Products Used on Sweet Cherries</i> , page 183.			
Cherry fruit fly	Use one of the insecticides listed for cherry fruit fly at Second cover .		
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall .		
Prepick			
Check preharvest interval before spraying. See Table 6-7. <i>Products Used on Sweet Cherries</i> , page 183.			
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall . Topas, Jade, Mission: Maximum of 2 applications in the 3 weeks prior to harvest.		
Postharvest orchard treatment			
Leaf spot	• Supra Captan 80 WDG (M) or Maestro 80 DF (M) • Flint (11) • Pristine WG (7+11) • Equal 65 WP (U12)	4.5 kg/ha 4.5 kg/ha 210 g/ha 750 g/ha 2.25 kg/ha	Necessary only where leaf spot is a problem or where sweet cherries are beside sour cherries. Captan, Maestro: May cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays. Flint: Do not apply where spray drift may reach Concord grapes.
Special sprays (when monitoring indicates the need)			
Japanese beetle	• Altacor (28) • Exirel (28)	285 g/ha 1.0–1.5 L/ha	Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Rating</i> , page 267. Apply when feeding is first observed and repeat in 10–14 days if required.
Obliquebanded leafroller (OBLR)	• Success (5) or Entrust SC (5) • Delegate WG (5) • Dipel 2X DF (11) or Bioprotec CAF (11) • Rimon 10 EC (15) • Altacor (28)	182 mL/ha 364 mL/ha 420 g/ha 1.125 kg/ha 4 L/ha 1.35–3.35 L/ha 285 g/ha	Routine monitoring is necessary to determine if OBLR is causing damage in sweet cherries. Dipel, Bioprotec: See <i>Using Organic and Biopesticide Products</i> , page 242. Delegate, Rimon, Altacor: For OBLR summer generation, apply at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch). Altacor: Will provide suppression of cherry fruit fly.

Disease or Insect	Product (Group)	Rate	Comments
Peachtree borer Lesser peachtree borer	• Isomate-PTB Dual • Sevin XLR (1) • Thionex 50 WSP (2) • Rimon 10 EC (15)	350 dispensers/ha 6.25 L/ha 1.5 kg/1,000 L water 1.4 L/1,000 L water	Isomate-PTB Dual: Reduces mating of peachtree and lesser peachtree borer. Apply before moth emergence begins, i.e., typically at or before shuck split. Insecticides may be needed as long as the maximum labelled rate is not exceeded. See <i>Mating Disruption in Fruit Crops</i> , page 250. Apply first spray 7 days after first adult catch in pheromone trap. Direct spray with a handgun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the second and third sprays. Sevin: For lesser peachtree borer only. Sevin, Thionex: Apply at 5–10-day intervals. Rimon: Apply at 3-week intervals.
Brown marmorated stink bug	• Malathion 85 E (1) • Clutch 50 WDG (4)	880 mL/ha 210–420 g/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before insect populations reach damaging threshold Malathion, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC (12) • Bio-Save 10 LP (NC)	496 mL/378 L water 50 g/100 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. Bio-Save: For suppression of blue mould and grey mould. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242.
Fall spray			
Bacterial canker	• Copper Spray (M) • Guardsman Copper Oxychloride 50 (M)	6–9 kg/1,000 L water 6–9 kg/1,000 L water	Apply when three-quarters of leaves have fallen.

Table 6-7. Products Used on Sweet Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Actara 25 WG	28408	thiamethoxam	4A	14 days	12 hours	2
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	5
Alias 240 SC	28475	imidacloprid	4A	10 days	24 hours	5
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /6 days ²	4
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Maximum 1 application per year with airblast sprayer for aphids or 3 applications per year with hand-held equipment for borer.

⁴ Before shuck fall.

⁵ Depends on rate. See label.

⁶ No more than 2 applications in the 3 weeks prior to harvest.

⁷ Hand harvest.

Table 6-7. Products Used on Sweet Cherries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	10 days	4 days	—
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust SC	30382	spinosad	5	7 days	when dried	3
Extrel	30895	cyantraniliprole	28	3 days	12 hours	4
GF-120 Fruit Fly Bait	28336	spinosad	5	0 days	when dried	10
Malathion 85 E	8372	malathion	1B	3 days	12 hours	2
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.12 L/ha
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success	26835	spinosad	5	7 days	when dried	3
Thionex 50 WSP	29990	endosulfan	2A	18 days	7 days ¹ /20 days ²	1/3 ³
Products used for control or suppression of diseases						
Bio-Save 10 LP	29673	<i>Pseudomonas syringae</i>	NC	postharvest	—	—
Bravo 500	15723	chlorothalonil	M	40 days	48 hours	3 ⁴
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper Spray	19146	copper oxychloride	M	1 day	48 hours	2
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Equal 65 WP	15608	dodine	U12	7 days	48 hours	2 ⁵
Flint	30619	trifloxystrobin	11	1 day	12 hours ¹ /7 days ²	5
Fontelis	30331	penthiopyrad	7	0 days	12 hours	max. 4.5 L/ha
Funginex DC	27686	triforine	3	prebloom	48 hours	3
Guardman Copper Oxychloride 50	13245	copper oxychloride	M	1 day	48 hours	2
Indar	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5 ⁶
Maestro 80 DF	26408	captan	M	2 days	48 hours	—
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5 ⁶
Nova 40 W	22399	myclobutanil	3	1 day	when dried	6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	when dried ¹ / 24 hours ² / 10 days ²	5
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	—
Topas	30163	propiconazole	3	3 days	72 hours	5 ⁶

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.² Hand thinning.³ Maximum 1 application per year with airblast sprayer for aphids or 3 applications per year with hand-held equipment for borer.⁴ Before shuck fall.⁵ Depends on rate. See label.⁶ No more than 2 applications in the 3 weeks prior to harvest.⁷ Hand harvest.

Growth Regulators for Sweet Cherries

Gibberellic acid (ProGibb 40 SB and Falgro)

Gibberellic acid (GA) delays fruit ripening 4–5 days and thus extends the picking period, which may delay the susceptibility to rain cracks. The treatment also increases fruit size, firmness and resistance to postharvest disorders.

- Dissolve 20 Falgro® tablets in 1,000 L of water to produce a 20 ppm solution and apply as a foliar spray to runoff.
- Apply 21 days before normal harvest when the fruit is at the straw-coloured stage.
- Harvest when fruits are at the desired shade of red but not within 21 days after spraying.

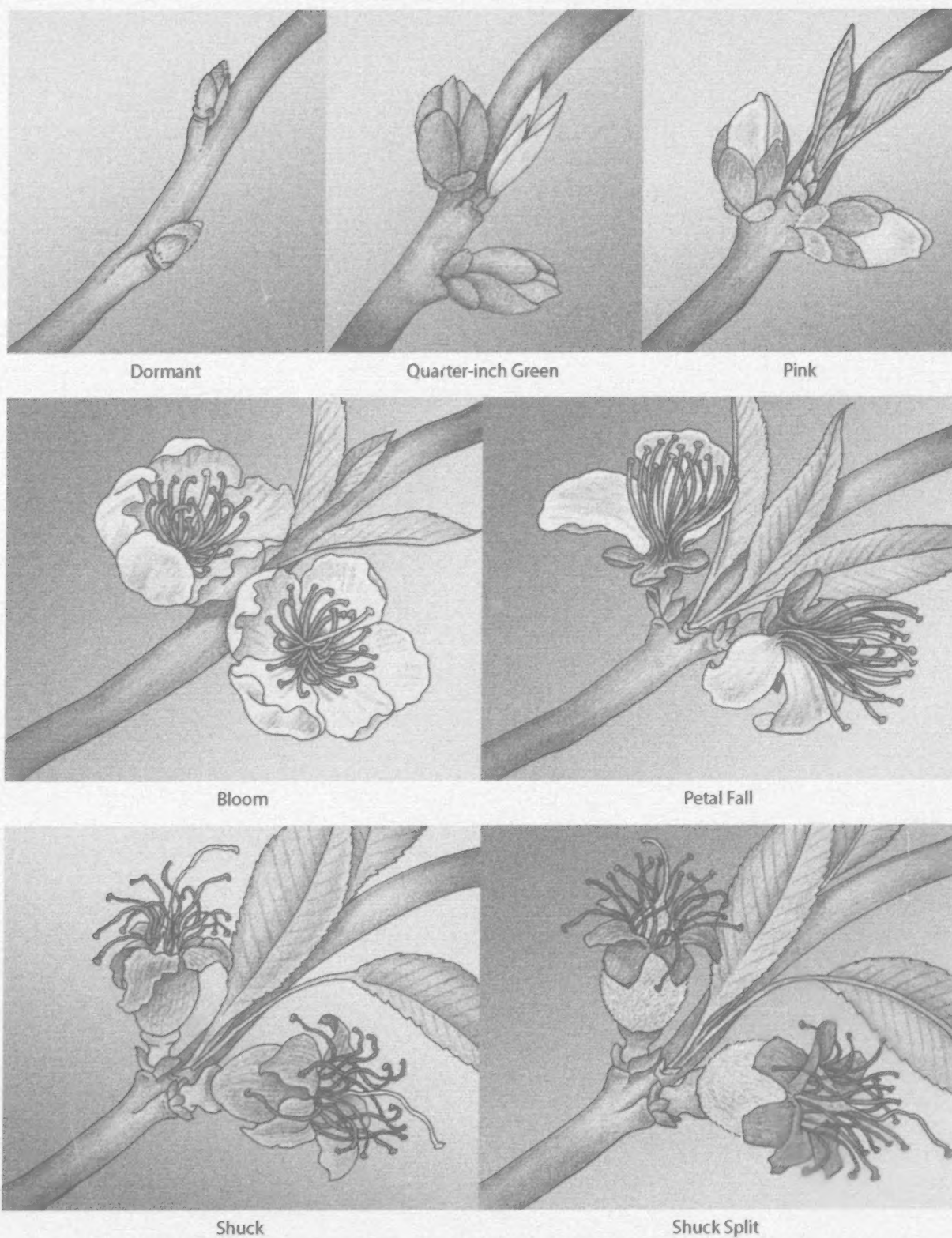
Prohexidione-calcium (Apogee)

Apogee can be used to reduce terminal growth in sweet cherries. Reduction in terminal growth should help reduce the time required to dormant prune as well as open up the tree canopy, leading to improved spray coverage and reduced disease pressure. For sweet cherries, growers can expect a significant reduction in terminal shoot growth – ranging from 20–50% in a given season by using Apogee at the proper timing and concentration.

- **Timing:** Terminal shoot growth in Ontario proceeds rapidly usually during the first 6 weeks of the season. Since 2 weeks are required for Apogee to slow growth effectively, it is essential to make the first application when terminal shoots are no longer than 2.5–5 cm. This typically coincides with late bloom, when sufficient leaf area has developed for Apogee to be translocated into the leaf. Apogee reportedly has no detrimental effects on bees, so the first application can be made before bees are removed from the orchard.

- **Rates:** Apply 45 g/100 L of dilute spray (which equates to 125 ppm or 125 mg/L of active ingredient) and spraying dilute (up to 3000 L/ha). A repeat application should be made 14–21 days later: this is important. Sprays are limited to a maximum of 2 sprays per season and a total of 2.7 kg of formulated product/ha/season. Based on the 125 ppm rate and a tree-row volume dilute rate of 2,000 litres/ha, 1.8 kg of product per hectare (728 g/acre) will be required.
- **Tank-mixing:** Calcium sprays should not be tank-mixed with Apogee.
- **Other precautions:** A spray adjuvant (Agral 90, LI-700) should be included to improve plant uptake of Apogee. In addition, where a high calcium or magnesium water source (hard water) is used, it is important to include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee. Effects of Apogee on fruit set, fruit size and yield are inconsistent based on results reported in the literature. Several studies have reported a resurgence in late-season growth in some situations when marked suppression of growth was achieved early in the season. Furthermore, some resurgence in growth the year following application has been observed. Therefore, fine-tuning of treatment timings and concentrations may need to be considered.

Figure 6-3. Peach Growth Stages



Peach Calendar

Read the product label and follow all safety precautions. All products labelled for use on peach can also be used on nectarine.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 6-8. *Products Used on Peaches*, page 193.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (M) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (NC) and the mode of action has not been determined for others (U or UN).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Nova, Topas, Indar, Jade, Funginex, Mission, Fontelis, Cantus, Vanguard, Elevate, Flint or Pristine when sporulating lesions of the target disease are present.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (oriental fruit moth, plum curculio), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to peaches during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (In March or early April before buds swell)			
Leaf curl	• Ferbam 76 WDG (M)	3.5 kg/1,000 L water	A delay in application may result in poor control of leaf curl. Ferbam: If mixing with oil, follow mixing directions on oil label carefully or poor leaf curl control will result. Bravo, Echo: Do not apply within 10 days of an oil application because it will burn flower and leaf tissue.
	• Bravo 500 (M)	7 L/ha	
	• Echo 720 (M)	3.5-4.9 L/ha	
	• Copper Spray (M)	2 kg/1,000 L water	
	• Guardsman Copper		
	Oxychloride 50 (M)	2 kg/1,000 L water	
San Jose scale	• Copper 53W (M)	1.9 kg/1,000 L water	Apply routinely every third year. If scale is a serious or continuing problem, apply for at least 2 consecutive years. Do not apply within 10 days of Bravo or Echo fungicides.
	• Superior 70 Oil (NC)	20 L/1,000 L water	
	• Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
Prebloom (half-inch green to first pink)			
European red mite	• Superior 70 Oil (NC)	20 L/1,000 L water	This is the preferred timing for red mite control if overwintering populations are high. Red mite populations are more likely to be high if pyrethroid sprays were used the previous year for oriental fruit moth and tarnished plant bug.
	• Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water	
Oriental fruit moth (OFM)	• Isomate-M Rosso	500 dispensers/ha	Reduces mating of OFM. Apply dispensers before OFM flight begins. See <i>Mating Disruption in Fruit Crops</i> , page 250. Isomate-M 100: Provides mating disruption for up to 90 days. Re-apply after 75–80 days, if needed. Isomate-M Rosso: Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first-generation OFM (see Shuck split).
	• Isomate-M 100	250 dispensers/ha	
Pink			
Brown rot (blossom blight stage)	• Granuflo T (M)	1.5–2.25 kg/1,000 L water	Granuflo T: For blossom blight, apply at intervals of 3–4 days during bloom. Senator, Rovral, Topas, Jade, Mission, Nova, Indar, Funginex, Cantus, Fontelis, Pristine, Vanguard, Elevate: These products are locally systemic and will penetrate petals to protect fruit from infection as blossoms start to open. Consult labels for information on drying time required before rain.
	• Thiram 75 WP (M)	1.5–2.25 kg/1,000 L water	
	• Senator 70 WP (1)	1.75 kg/ha	
	• Rovral WDG (2)	1.5 kg/ha	
	• Topas (3)	500 mL/ha	
	• Jade (3)	500 mL/ha	
	• Mission 418 EC (3)	300 mL/ha	
	• Nova 40 W (3)	340 g/ha	
	• Indar (3)	140 g/ha	
	• Funginex DC (3)	2.5 L/ha	
	• Cantus WDG (7)	370 g/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
	• Pristine WG (7+11)	750 g/ha	
	• Vanguard 75 WG (9)	370 g/ha	
	• Elevate 50 WDG (17)	1.7 kg/ha	
Bloom			
DO NOT APPLY INSECTICIDES WHILE PEACH TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Brown rot (blossom blight stage)	Use one of the fungicides listed for brown rot at Pink . Spray when first blossoms are opening. Repeat every 4–5 days if weather is wet.		
Petal fall to shuck			
Brown rot	Use one of the fungicides listed for brown rot at Pink . Repeat every 4–5 days if weather is wet.		
Aphids	• Clutch 50 WDG (4)	140–210 g/ha	Clutch: Use high rate and short intervals under high pressure. Re-apply 10–14 days later, if needed. Beleaf: Use high rate for high pressure and/or dense foliage. Movento: Most effective on young stages of aphids. Control may not be apparent for 2–3 weeks. Under high pressure, a second application may be necessary 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Purespray Green Spray Oil 13E: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Do not apply less than 1,000 L water/ha (1% solution). Tolerance has not been determined for all varieties; test a small area of each variety prior to spraying the whole block. Do not apply within 14 days of Supra Captan, Maestro, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures, when temperatures are high (above 25°C), to crops under moisture stress, or just prior to rain. Read the label carefully for other precautions. See <i>Using Organic and Biopesticide Products</i> , page 242.
	• Alias 240 SC (4)	233 mL/ha	
	• Beleaf 50 SG (9)	120–160 g/ha	
	• Movento 240 SC (23)	365 mL/ha	
	• Purespray Green Spray Oil 13E (NC)	10 L/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
Green peach aphid	- Admire 240 F (4) - or Alias 240 SC (4) - Clutch 50 WDG (4) - Closer SC (4) - Exirel (28) - Purespray Green Spray Oil 13E (NC)	230 mL/ha 233 mL/ha 140–210 g/ha 100–200 mL/ha 0.75–1.5 L/ha 10 L/1,000 L water	Apply when 30% of terminals are infested or 20 colonies per tree for peaches and 10% of terminals are infested or 5–10 colonies per tree for nectarines. Clutch: Use high rate and short interval under high pressure. Re-apply 10–14 days later, if needed. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Purespray Green Spray Oil 13E: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Do not apply less than 1,000 L water/ha (1% solution). Tolerance has not been determined for all varieties; test a small area of each variety prior to spraying the whole block. Do not apply within 14 days of Supra Captan, Maestro, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur, within 48 hours of freezing temperatures, when temperatures are high (above 25°C), to crops under moisture stress, or just prior to rain. Read the label carefully for other precautions. <i>Using Organic and Biopesticide Products</i>, page 242.
Western flower thrips (suppression)	- Success (5) - or Entrust SC (5)	182 mL/ha 364 mL/ha	Western flower thrips is a problem primarily in nectarine. Use sufficient water volume to ensure that spray washes down into the shuck where thrips hide.
Shuck split to shuck fall			
Oriental fruit moth (OFM) (first generation)	- Lorsban 50 W (1) - Assail 70 WP (4) - Rimon 10 EC (15) - Intrepid 240 F (18) - Exirel (28)	3.5 kg/ha 120–240 g/ha 1.35–3.35 L/ha 1.5 L/ha 500–750 mL/ha	Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. Apply within the specified degree-day (DDC, base 7.2°C) after sustained moth catch in pheromone traps. Re-apply 10–14 days later if catch is extended. Lorsban: Apply at 200 DDC. Assail, Intrepid: Apply at 100–140 DDC. Rimon: Apply at 111–139 DDC. Exirel: Apply at 194–208 DDC. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Assail: For optimum activity, use 240 g/ha in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Lorsban, Intrepid: Use for control of first-generation OFM only. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Do not use pyrethroids for control of first-generation OFM.
Powdery mildew	- Fontelis (7) - Flint (11)	1.0–1.75 L/ha 140–280 g/ha	Flint: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267.
Plum curculio	- Pounce 384 EC (3) - or Perm-Up (3) - Assail 70 WP (4) - Clutch 50 WDG (4) - Exirel (28)	520 mL/ha 520 mL/ha 240 g/ha 210 g/ha 1.0–1.5 L/ha	Plum curculio is a sporadic pest of peaches and nectarines. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg-laying scars. A border spray of 4–6 rows may provide sufficient control. Check developing fruit for new damage 7–10 days later. Pounce, Perm-Up, Assail: Under high pressure, may provide suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Peachtree borer Lesser peachtree borer	• Isomate-PTB Dual	375–675 dispensers/ha	Reduces mating of peachtree and lesser peachtree borer. Apply pheromone dispensers before borer flight begins in the spring, i.e., typically apply at or before shuck split. The dispenser is designed to last an entire season. Apply at least 375 dispensers/ha for low-pressure sites and up to 675 dispensers/ha for high-pressure sites. An insecticide for peachtree borer may also be needed. Typically only 1 application per season is made, but multiple applications can be made as long as the maximum labelled use rate is not exceeded in the course of the season. Populations are generally reduced over time where mating disruption is used for several seasons. For more information, see <i>Mating Disruption in Fruit Crops</i> , page 250.
Brown rot	• Supra Captan 80 WDG (M) 4.5 kg/ha • or Maestro 80 DF (M) 4.5 kg/ha • Microscopic Sulphur (M) 6.5 kg/1,000 L water • Granuflo T (M) 1.5–2.25 kg/1,000 L water • or Thiram 75 WP (M) 1.5–2.25 kg/1,000 L water • Rovral WDG (2) 1.5 kg/ha • Topas (3) 500 mL/ha • or Jade (3) 500 mL/ha • or Mission 418 EC (3) 300 mL/ha • Indar (3) 140 g/ha • Cantus WDG (7) 370 g/ha • Fontelis (7) 1.0–1.75 L/ha • Pristine WG (7+11) 750 g/ha • Vanguard 75 WG (9) 740 g/ha • Elevate 50 WDG (17) 1.7 kg/ha		This is a critical period for infection as the fungus can grow from the dying shuck into the susceptible fruit. This results in latent infections that are not expressed until the fruit starts to mature. Re-apply in 7 days if wet weather persists. Sulphur: May lead to mite outbreaks. Granuflo: For fruit rot, apply at petal fall and 2 weeks later. Rovral, Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Vanguard, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain. Pristine: Do not apply where spray drift may reach Concord grapes as it may cause crop injury.
Scab	• Kumulus DF (M) 22.5 kg/ha • or Microthiol Dispers (M) 22.5 kg/ha • or Microscopic Sulphur (M) 6.5 kg/1,000 L water • Supra Captan 80 WDG (M) 3.75–4.5 kg/ha • or Maestro 80 DF (M) 3.75–4.5 kg/ha • Granuflo T (M) 1.5–2.25 kg/1,000 L water • or Thiram 75 WP (M) 1.5–2.25 kg/1,000 L water • Fontelis (7) 1.5 L/ha		Peaches are susceptible to peach scab fruit infections from shuck fall to about 4–6 weeks before harvest. For nectarine, the susceptible period begins earlier (at shuck split) due to the lack of protective hairy fruit covering. This period marks the greatest scab risk, given the presence of large spore numbers and the increased susceptibility of the developing fruit. Closely spaced applications with effective fungicides are recommended, particularly for the shuck fall application and during rainy weather. See Table 6-11. <i>Activity of Fungicides on Tender Fruit Diseases</i> , page 216, for products that control scab.
European red mite	• Apollo SC (10)	300 mL/ha	If oil was applied in the spring, a miticide is likely not necessary at this time. Apollo: Most effective on eggs and newly hatched nymphs. Apply when leaf tissue is present and before there are 3 active mites per leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall.
Lesser peachtree borer Peachtree borer	• Sevin XLR (1) • Thionex 50 WSP (2) • Rimon 10 EC (15)	6.25 L/ha 1.5 kg/1,000 L water 1.4 L/1,000 L water	Peachtree borers are sporadic pests. Spray in areas with high borer populations. Use pheromone traps to monitor adult activity and begin sprays 1 week after first flight. Make 3 applications at 5–10-day intervals. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly. Sevin, Thionex: Maximum of 3 applications per season at 5–10-day intervals. Sevin XLR: For lesser peachtree borer only. Thionex: Do not apply second spray to varieties in the Harrow Diamond and Garnet Beauty season; on these varieties use Sevin XLR. Do not use third spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season. Rimon: Apply at 3-week intervals.
Western flower thrips (suppression)	Use one of the insecticides listed for western flower thrips at Petal fall .		

Disease or Insect	Product (Group)	Rate	Comments
Special sprays (when monitoring indicates the need during early green fruit stage to pit hardening)			
Tarnished plant bug	- Ripcord (3) - or Up-Cyde 2.5 EC (3) - Matador 120 EC (3) - or Silencer 120 EC (3) - Ambush 500 EC (3) - or Pounce 384 EC (3)	175 mL/ha 280 mL/ha 104 mL/ha 104 mL/ha 400 mL/ha 520 mL/ha	General timing is mid-June if 2% or more fruit damage is observed. Where plant bug pressure is high and significant new damage is detected, repeat spray in 5–7 days. Plant bug pressure is lower in orchards with managed sod. Other cultural techniques can reduce damage from this pest. Ripcord: Also controls oak bug. Up-Cyde: Use in 550 L water/ha.
Second-generation oriental fruit moth (OFM) spray			
Oriental fruit moth (OFM) (Second generation)	- Ripcord (3) - or Up-Cyde 2.5 EC (3) - Matador 120 EC (3) - or Silencer 120 EC (3) - Ambush 500 EC (3) - or Pounce 384 EC (3) - or Perm-Up (3) - Decis 5 EC (3) - Assail 70 WP (4) - Delegate WG (5) - Rimon 10 EC (15) - Altacor (28) - Exirel (28)	175 mL/ha 280 mL/ha 104 mL/ha 104 mL/ha 200–400 mL/ha 275 mL/ha 275 mL/ha 200 mL/ha 120–240 g/ha 420 g/ha 1.35–3.35 L/ha 285 g/ha 500–750 mL/ha	If mating disruption for OFM is being used, a pesticide application is not required for second-generation OFM. Spray all varieties. This generation may require 2 insecticide sprays. Apply within the specified degree-day (DDC, base 7.2°C) after sustained first-generation moth catch in pheromone traps. Check the harvest dates of early varieties and do not spray within the preharvest interval. Ripcord, Up-Cyde, Matador, Silencer, Ambush, Pounce, Perm-Up, Decis, Delegate, Altacor, Exirel: Apply at 639–667 and again at 805–833 DDC. Assail: Apply at 583–611 DDC and again at 750–778 DDC. Rimon: Apply at 555–583 DDC and again at 722–750 DDC. See Appendix B: Degree-Day Modeling, page 291. Up-Cyde: Use in 550 L water/ha. Assail: For optimum activity, use 240 g/ha in a minimum spray volume of 1,000L/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Brown rot (early varieties only – Harrow Diamond through Sunhaven)	- Supra Captan 80 WDG (M) - or Maestro 80 DF (M) - Microscopic Sulphur (M) - Granuflo T (M) - or Thiram 75 WP (M) - Rovral WDG (2) - Topas (3) - or Jade (3) - or Mission 418 EC (3) - Indar (3) - Cantus WDG (7) - Fontelis (7) - Pristine WG (7+11) - Vanguard 75 WG (9) - Elevate 50 WDG (17)	4.5 kg/ha 4.5 kg/ha 6.5 kg/1,000 L water 1.5–2.25 kg/1,000 L water 1.5–2.25 kg/1,000 L water 1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 1.0–1.75 L/ha 750 g/ha 740 g/ha 1.7 kg/ha	Sulphur: May lead to mite outbreaks. Rovral, Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Vanguard, Elevate: These products are locally systemic. Consult labels for information on drying time required before rain. Topas, Jade, Mission: Maximum 2 applications of any of these products in the 3 weeks prior to harvest.
Powdery mildew	Use one of the fungicides listed for powdery mildew at Shuck split to shuck fall .		
Scab	Use one of the fungicides listed for scab at Shuck split to shuck fall .		
Special sprays (when monitoring indicates the need)			
European red mite Two-spotted spider mite	- Nexter (21) - Envidor 240 SC (23)	300 g/ha 750 mL/ha	Check product labels and Table 6-8. <i>Products Used on Peaches</i>, page 193, for preharvest intervals. Apply this spray around the second OFM spray (early July) if needed. On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. Spray if 5–10 active pest mites per leaf are present in July and few beneficial mites are present. Monitor carefully because populations of pest mites can build rapidly. Miticides are best used alone. Use a minimum water volume of 1,000 L/ha for effective control. Nexter: Most effective when applied to mite nymphs. Use 600 g/ha for two-spotted spider mites. Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.

Disease or Insect	Product (Group)	Rate	Comments
Japanese beetle	- Imidan 70-WP Instapak (1) - Altacor (28) - Exirel (28)	2.68 kg/ha 285 g/ha 1.0–1.5 L/ha	Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Brown marmorated stink bug	- Malathion 85 E (1) - Clutch 50 WDG (4)	855 mL/ha 210–420 g/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before insect populations reach damaging threshold Malathion, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Third-generation oriental fruit moth (OFM) spray (late varieties) Check preharvest interval before spraying early maturing peaches. See Table 6-8. <i>Products Used on Peaches</i> , page 193.			
Oriental fruit moth (OFM)	- Ripcord (3) - or Up-Cyde 2.5 EC (3) - Pounce 384 EC (3) - or Perm-Up (3) - or Ambush 500 EC (3) - Decis 5 EC (3) - Silencer 120 EC (3) - Assail 70 WP (4) - Delegate WG (5) - Rimon 10 EC (15) - Altacor (28) - Exirel (28)	175 mL/ha 280 mL/ha 275 mL/ha 275 mL/ha 200–400 mL/ha 200 mL/ha 104 mL/ha 120–240 g/ha 420 g/ha 1.35–3.35 L/ha 285 g/ha 500–750 mL/ha	If mating disruption for OFM is being used, a pesticide application is not required for third-generation OFM. This spray is usually required for all varieties from Vivid season and later. Apply within the specified degree-day (DDC, base 7.2°C) after sustained moth catch in pheromone traps. Check the preharvest intervals. Ripcord, Up-Cyde, Pounce, Perm-Up, Ambush, Decis, Silencer Delegate, Altacor, Exirel: Apply at 1,167–1,222 DDC and again at 1,361–1,389 DDC. Assail: Apply at 1,111–1,167 DDC and again at 1,305–1,389 DDC. Rimon: Apply at 1,083–1,139 and again at 1,277–1,305 DDC. See Appendix B: <i>Degree-Day Modeling</i> , page 291. Up-Cyde: Use in 550 L water/ha. Assail: For optimum activity, use 240 g/ha in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Brown rot	Use one of the fungicides listed for brown rot at Second-generation oriental fruit moth (OFM) spray . Topas, Jade, Mission: Maximum 2 applications in the 3 weeks prior to harvest.		
Prepick spray Check preharvest interval before spraying early maturing peaches. See Table 6-8. <i>Products Used on Peaches</i> , page 193.			
Oriental fruit moth (OFM)	- Decis 5 EC (3) - Ripcord (3) - or Up-Cyde 2.5 EC (3) - Pounce 384 EC (3) - or Perm-Up (3) - or Ambush 500 EC (3) - Silencer 120 EC (3) - Assail 70 WP (4) - Delegate WG (5) - Rimon 10 EC (15) - Altacor (28) - Exirel (28)	200 mL/ha 175 mL/ha 280 mL/ha 275 mL/ha 275 mL/ha 200–400 mL/ha 104 mL/ha 120–240 g/ha 420 g/ha 1.35–3.35 L/ha 285 g/ha 500–750 mL/ha	Spray each variety when first colour shows, 7–14 days before first harvest. If mating disruption is being used for OFM, a prepick spray is not necessary unless local populations have historically been high or in cases where late-season peaches are the only remaining fruit in an area. Up-Cyde: Use in 550 L water/ha. Assail: For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Brown rot	Use one of the fungicides listed for brown rot at Second-generation oriental fruit moth (OFM) spray . Apply with OFM sprays 7–10 days before harvest. Topas, Jade, Mission: Maximum 2 applications in the 3 weeks prior to harvest.		

Disease or Insect	Product (Group)	Rate	Comments
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC (12)	496 mL/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.
Fall spray			
Leaf curl	• Bravo 500 (M) or Echo 720 (M) • Copper Spray (M) • Guardsman Copper Oxychloride 50 (M)	7 L/ha 3.5–4.9 L/ha 2 kg/1,000 L water 2 kg/1,000 L water	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying.

Table 6-8. Products Used on Peaches

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	2
Alias 240 SC	28475	imidacloprid	4A	7 days	24 hours	2
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Ambush 500 EC	14882	permethrin	3	7 days	12 hours	—
Apollo SC	21035	clofentezine	10	21 days	12 hours	1
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /6 days ²	4
Beleaf 50 SG	29796	flonicamid	9C	14 days	12 hours ¹ /48 hours ²	3
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)
Decis 5 EC	22478	deltamethrin	3	1 day	12 hours	1
Delegate WG	28778	spinetoram	5	14 days	12 hours	3
Entrust SC	30382	spinosad	5	14 days	when dried	3
Envior 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4
Imidan 70-WP Instapak	29064	phosmet	1B	14 days	7 days ¹ /14 days ¹ / 30 days ²	4
Intrepid 240 F	27786	methoxyfenozide	1B	14 days	12 hours	1
Lorsban 50 W	20944	chlorpyrifos	1B	21 days	4 days	2
Malathion 85 E	8372	malathion	1B	7 days	12 hours	2
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.12 L/ha
Nexter	25135	pyridaben	21	14 days	24 hours	1
Perm-Up	28877	permethrin	3	7 days	12 hours	—

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pick-your-own harvest.

⁴ No more than 2 applications in the 3 weeks prior to harvest.

⁵ Hand harvest.

⁶ Personal protective equipment required for certain activities. See label.

Table 6-8. Products Used on Peaches (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Pounce 384 EC	16688	permethrin	3	7 days	when dried	—
Purespray Green Spray Oil 13E	27666	mineral oil	NC	—	12 hours	—
Ripcord	30316	cypermethrin	3	7 days	12 hours	2
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	1 day	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success	26835	spinosad	5	14 days	when dried	3
Superior 70 Oil	9542 14981	mineral oil	NC	prebloom	12 hours	—
Thionex 50 WSP	29990	endosulfan	2A	18 days	7 days ¹ /20 days ²	3
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	2
Products used for control or suppression of diseases						
Bravo 500	15723	chlorothalonil	M	60 days	48 hours	3
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper 53 W	9934	basic copper sulphate	M	before bud swell or after leaf drop	48 hours	2
Copper Spray	19146	copper oxychloride	M	before bud swell or after leaf drop	48 hours	2
Echo 720	29355	chlorothalonil	M	40 days	48 hours	—
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	21 days	12 hours	—
Flint	30619	trifloxystrobin	11	1 day	12 hours ¹ /7 days ²	4
Fontelis	30331	penthiopyrad	7	0 days	12 hours	max. 4.5 L/ha
Funginex DC	27686	triforine	3	prebloom	48 hours	3
Granuflo T	30548	thiram	M	7 days	24 hours	7
Guardsman Copper Oxychloride 50	13245	copper oxychloride	M	before bud swell or after leaf drop	48 hours	2
Indar	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5 ⁴
Kumulus DF	18836	sulphur	M	1 day	24 hours	8
Maestro 80 DF	26408	captan	M	2 days	48 hours	—
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5 ⁴
Nova 40 W	22399	myclobutanil	3	1 day	when dried	6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	when dried ¹ / 24 hours ² /10 days ²	5
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.² Hand thinning.³ Pick-your-own harvest.⁴ No more than 2 applications in the 3 weeks prior to harvest.⁵ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Table 6-8. Products Used on Peaches (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	—
Thiram 75 WP	27556	thiram	M	7 days	12 hours	7
Topas	30163	propiconazole	3	3 days	72 hours	5 ⁴
Vanguard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pick-your-own harvest.

⁴ No more than 2 applications in the 3 weeks prior to harvest.

⁵ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Thinning Peaches

Peach thinning is an essential orchard management practice, which is necessary to:

- obtain good fruit size
- improve fruit quality and colour
- reduce limb breakage
- manage tree vigour
- avoid a shortened orchard life

When thinning, consider fruit load as well as fruit spacing. Optimum fruit load depends on cultivar, tree vigour, tree age and health, and orchard management practices such as tree spacing, irrigation and pruning. Peach growers tend to space the fruit 15–20 cm apart. However, distance between fruit is less critical as long as clusters are broken up and fruit is separated. Tree crop load (kg per tree or number of fruit per tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 tons/acre) in an orchard with a tree density of 490 trees per ha (200 trees per acre) requires about 200–300 fruit per tree, if you assume an average fruit size of 4–7 fruit per kg (2–3 fruit per lb). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruit per tree may be more ideal, at least for cultivars that normally produce large fruit.

Factors to consider when thinning peaches

Timing

Start hand thinning near the end of June drop (about mid-June) when it can be determined which fruits will abort naturally. Thinning at early fruit development

or even blossom time is more beneficial than late thinning. However, it is more risky since it is difficult to get a true assessment of crop load before June drop occurs. Always thin early ripening cultivars in order to obtain good fruit size. In some years, a follow-up hand thinning may be necessary.

Pruning

Pruning selectively removes fruit-bearing surface, as well as some of the excess crop. Thinning in peaches generally occurs during bloom and fruit thinning by hand must follow to avoid over-cropping. Summer pruning can be used to open the fruit canopy, and improve fruit quality and bud development for subsequent years.

Cultivars

Cultivar selection over the years has tended towards larger fruit. Earlier ripening cultivars have a high percentage of fruit with split pits. Some growers thin early cultivars twice: thinning lightly to remove some crop load, then a second time to selectively remove split-pit fruit. Harrow Diamond is the earliest-ripening commercial cultivar that has few split-pit fruits under normal conditions. This cultivar must be well-thinned to obtain suitable size.

There is little likelihood of over-thinning early cultivars when the set is heavy. Hard-to-size cultivars such as Redhaven require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, late-maturing cultivars with a good, uniform set are thinned to 10–13 cm between fruit. Thin each cultivar according to its individual requirements.

Irrigation

Irrigation is recommended to enhance fruit size, especially in long periods of dry conditions. There are two key periods to irrigate peaches; during cell division (from bloom to 30 days after bloom) and during cell expansion (approximately 2–4 weeks before harvest). Start irrigation early in the season and continue a regular schedule based on the amount of rainfall, rate of evapo-transpiration and soil water-holding capacity.

Permanent orchard sod is very competitive and increases moisture requirements. Adjust the irrigation schedule based on additional factors such as crop load, winter injury, pest pressure or other stress factors. Soil moisture probes are now available that can provide information on soil moisture levels.

Orchards without irrigation may, in some years, need a second thinning during July to attain marketable fruit size.

Thinning methods

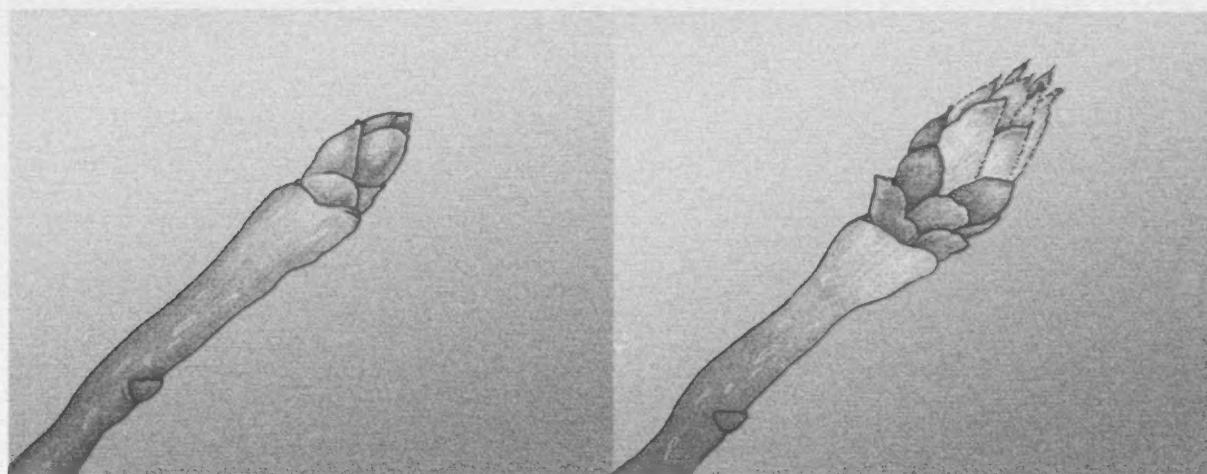
Thinning is most commonly accomplished by hand. Large quantities of fruit can be removed quickly with physical aids, such as a child's plastic bar, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose.

Follow this initial thinning with touch-up thinning a few days later to assure that fruit numbers per tree produce good-sized fruit for the cultivar and orchard condition. Ensure clusters of fruit are broken up and fruit separated. If the set is spotty on the tree, more fruit may be left on the heavy-set branches.

Other methods that have been investigated are:

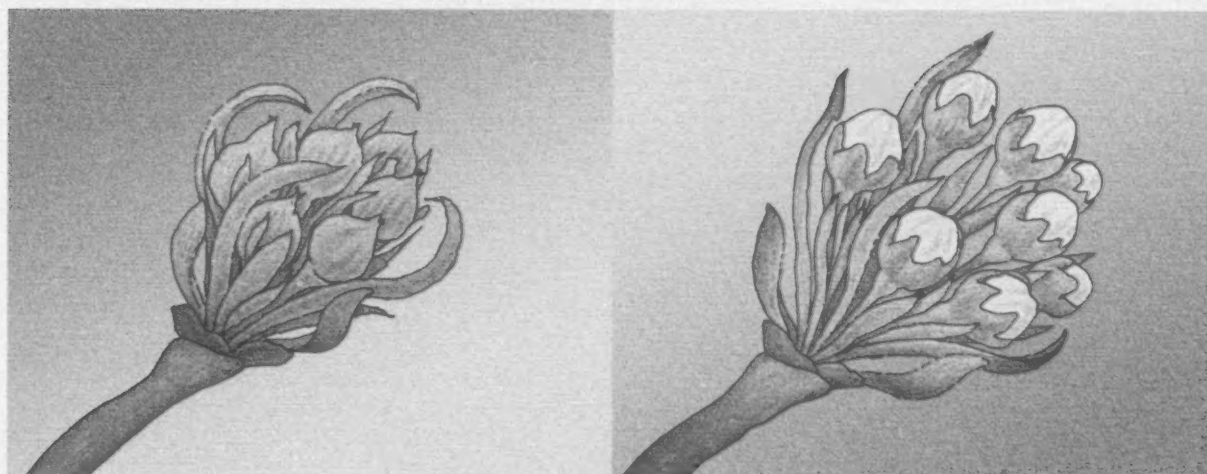
- **Mechanical blossom thinning:** The Darwin mechanical thinner, which is showing promise for blossom removal, is a relatively new device using nylon cords fixed to a rotating shaft mounted on a front-end loader. Tractor speed, rpm of nylon cords, number of cords used, tree shape and timing during blossom can affect the number of blossoms removed. Follow-up hand thinning is necessary to ensure good fruit size. Mechanical blossom thinning helps to reduce labour costs, and results in larger average fruit size per tree and earlier ripening. This new technology may work best in high density, vertically trained spindle orchards.
- **Chemical thinning:** No chemicals are registered for thinning peaches in Ontario.

Figure 6-4. Pear Growth Stages



Dormant

Green Tip



Tight Cluster

White Bud



Bloom

Petal Fall/Calyx

Pear Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period and maximum number of applications, see Table 6-9. *Products Used on Pears*, page 205.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Nova, Inspire Super, Scala, Equal, Syllit, Cantus, Flint, Sovran, Pristine or Fontelis when sporulating scab lesions are present.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (pear psylla, oriental fruit moth, codling moth, obliquebanded leafroller) do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (mites), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to pears during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant			
Scale insects	• Superior 70 Oil (<i>NC</i>)	20 L/1,000 L water	Use 2,000–3,000 L of water/ha. Good coverage is essential. Do not apply full rate of oil more than once per season.
Pear psylla	• Purespray Green Spray Oil 13E (<i>NC</i>)	20 L/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
Green tip			
Scab	- Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Inspire Super (3+9) - Scala SC (9) - Fontelis (7) - Pristine WG (7+11) - Flint (11) - Sovran (11) - Serenade MAX (44) - Buran (U) - Equal 65 WP (U12) or Syllit 400 FL (U12) plus Supra Captan 80 WDG or Maestro 80 DF	3.75 kg/ha 3.75 kg/ha 560–836 mL/ha 1 L/ha 1.0–1.5 L/ha 1.0–1.2 kg/ha 140 g/ha 240 g/ha 3–6 kg/ha 18 L/ha 3.25 kg/ha 5.28 L/ha 2.8 kg/ha 2.8 kg/ha	Start scab control early and re-apply if weather remains wet. Captan, Maestro: Do not use on d'Anjou pears. Do not use within 14 days of oil. Inspire Super: Not efficacious on fruit scab. Use during primary scab period only. Scala: Do not apply postbloom. Inspire Super, Scala, Fontelis, Pristine, Flint, Sovran, Equal, Syllit: These products are locally systemic. Consult labels for information on drying time required before rain. Fontelis: Begin applications at green tip and continue as needed on a 7–10-day interval. Use high rate and short interval under high disease pressure. Maximum of 2 applications per season. Sovran, Flint, Pristine: Should not be used at this stage due to resistance management considerations and label restrictions on the maximum number of allowable sprays. These materials should not be used until White bud to Bloom or later, when they are likely to be most beneficial. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. Buran: Re-apply 7–14 days when conditions are conducive to disease development. This is a new product in Ontario and little evidence of its efficacy is available.
European red mite	Superior 70 Oil (NC)	20 L/1,000 L water	Best applied at or near Green tip for mites. Use 2,000–3,000 L of water per ha. Good coverage is essential. Oil does not control rust mite. Do not apply full rate of oil more than once per season.
Pear psylla	Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water	
Pear psylla	- Ambush 500 EC (3) - Surround WP (NC)	400 mL/ha 50 kg/ha	Surround: Begin spray program before overwintering adults are active. Make 2 applications at 50 kg/ha, 7 days apart, to establish a base layer. Continue applications at 7–14-day intervals. Surround may interfere with optimum bee activity. Do not apply Surround during the tight cluster to petal fall stage. See <i>Using Organic and Biopesticide Products</i>, page 242.
Oriental fruit moth (OFM)	- Isomate-M Rosso - Isomate-M 100	500 dispensers/ha 250 dispensers/ha	Reduces mating for OFM. Apply before moth flight begins. See <i>Mating Disruption in Fruit Crops</i>, page 250. Isomate-M 100: Provides mating disruption for up to 90 days. Make a second application 75–80 days later. Isomate-M Rosso: Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first-generation OFM (see Petal fall).
White bud (white petals showing on flowers)			
Scab	Use one of the fungicides listed for scab at Green tip . Start scab control early and repeat the spray at 7–10-day intervals if weather remains wet.		
Pear psylla	- Ambush 500 EC (3) - Assail 70 WP (4) - Calypso 480 SC (4) - Nexter (21)	400 mL/ha 120 g/ha 290–440 mL/ha 600 g/ha	To avoid resistance problems, do not use pyrethroids at this stage. Refer to comments at First cover. Calypso: Apply high rate under high pressure. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7–10-day intervals if needed. Nexter: There is little commercial experience with this product for psylla.
Codling moth (CM) Oriental fruit moth (OFM)	Isomate-CM/OFM TT	200–500 dispensers/ha	Reduces mating of codling moth (CM) and oriental fruit moth (OFM). Apply prior to flight of codling moth, no later than petal fall. Most orchards will require insecticides applied for one or both CM generations to avoid unacceptable levels of damage. Product lasts for up to 150 days for CM and up to 90 days for OFM. See <i>Mating Disruption in Fruit Crops</i> , page 250.

Disease or Insect	Product (Group)	Rate	Comments
Bloom			
There are special pollination requirements for pears. See Pollination Requirements for Fruit Crops at www.ontario.ca/crops .			
DO NOT APPLY INSECTICIDES WHILE PEARS ARE IN BLOOM. SEE BEE POISONING, PAGE 269.			
Fire blight	- Copper 53 W (M) lime/1,000 L water - Kasumin 2L (24) - Streptomycin 17 (25) - Serenade MAX (44) - Bloomtime Biological FD (NC) - Blossom Protect (NC)	1 kg/ha plus 6 kg 5 L/ha 600 g/1,000 L 3–6 kg/ha 375–500 g/ha - See comments.	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Do not use alternate tree-row application method. Use alone for best results. For more information, refer to www.ontario.ca/cropipm. Kasumin: Apply at 20–30% bloom or when conditions favour disease development. Do not make more than 2 consecutive applications. Do not apply after petal fall. Streptomycin: UV light-sensitive, so is effective for only 2–3 days. If warm, wet conditions (above 20°C) prevail, 2–3 sprays during bloom may be required. Do not use after Copper 53 W. Serenade MAX, Bloomtime: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 and <i>Using Organic and Biopesticide Products</i>, page 242. Bloomtime: Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15–20% bloom, second application at full bloom to petal fall. Product has specific handling requirements. See label for storage requirements. Blossom Protect: For every 1 m of tree height, dilute 5.25 kg Component A in 500 L/ha water and add dilution to 0.75 kg Component B. If a forecast system (e.g., Maryblyt, Cougar Blight) is available, apply 1–2 days before an infection date. Repeat after 2 days and up to 5 times if infection continues. If no forecast system is available, apply at 10, 40, 70 and 90% open blossoms. Copper: Pre-mix hydrated lime in a pail with enough water to make a slurry. Pour through a 0.3 mm screen into spray tank partly filled with water and with mechanical agitator running. Allow 15 minutes of mixing before spraying. Maintain agitation throughout application. Incompatible with all other insecticides and fungicides.
Scab	- Supra Captan 80 WDG (M) or Maestro 80 DF (M) - Nova 40 W (3) - Inspire Super (3+9) - Fontelis (7) - Pristine WG (7+11) - Flint (11) - Sovran (11) - Scala SC (9) - Serenade MAX (44) - Buran (U) - Equal 65 WP (U12) or Syllit 400 FL (U12) plus Supra Captan 80 WDG - or Maestro 80 DF	3.75 kg/ha 3.75 kg/ha 340 g/ha 560–836 mL/ha 1.0–1.5 L/ha 1.0–1.2 kg/ha 140 g/ha 240 g/ha 1 L/ha 3–6 kg/ha 18 L/ha 3.25 kg/ha 5.28 kg/ha 2.8 kg/ha 2.8 kg/ha	Supra Captan, Maestro: Do not use on d'Anjou pears. Nova, Inspire Super, Fontelis, Pristine, Flint, Sovran, Scala, Equal, Syllit: These products are locally systemic. Consult labels for information on drying time required before rain. Nova: Apply in 500–1,000 L/water. Nova, Inspire Super: For improved fruit scab control, combine with a protectant fungicide. Sovran: Where disease pressure is high, use up to 360 g/ha. Scala: Do not apply postbloom. Serenade MAX: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267, and <i>Using Organic and Biopesticide Products</i>, page 242. Buran: Subsequent applications may be made every 7–14 days when conditions are conducive to disease development. This is a new product in Ontario and little evidence of its efficacy is available.
Petal fall			
Plum curculio	- Actara 25 WG (4) - Calypso 480 SC (4) - Clutch 50 WDG (4) - Exirel (28)	385 g/ha 440 mL/ha 210 g/ha 1.0–1.5 L/ha	Actara: Do not apply when bees are in the orchard. Calypso: Optimal timing is petal fall plus 3 days. However, if monitoring indicates plum curculio is in the orchard prior to this timing, then insecticides should be applied at petal fall. Clutch: Make first application before populations reach damaging thresholds. If pest pressure continues, re-apply 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Pear psylla	• Ambush 500 EC (3)	400 mL/ha	Actara: Do not apply when bees are in the orchard. Calypso: Apply high rate under high pressure. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7–10-day intervals if needed. Clutch: Make first application before populations reach damaging thresholds. If pest pressure continues, re-apply 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Agri-Mek: Do not use within 14 days of Supra Captan or Maestro. Apply no later than 21 days after petal fall for best results. Apply with 10 L oil and a minimum of 1,000 L of water per ha, when most mites are in the nymph stage. May cause russetting to d'Anjou and other sensitive varieties. Maximum 1 application per season. Alternate yearly with other insecticides. Agri-Mek will not control plum curculio. Movento: Control may not be apparent for 2–3 weeks. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Do not use when fruit is present due to the possibility of injury. If psylla pressure is high, use the higher labelled rate of 435 mL/ha.
	• Assail 70 WP (4)	120 g/ha	
	• Actara 25 WG (4)	385 g/ha	
	• Clutch 50 WDG (4)	280–420 g/ha	
	• Calypso 480 SC (4)	290–440 mL/ha	
	• Agri-Mek 1.9% EC (6)	1 L/ha	
	• Nexter (21)	600 g/ha	
Obliquebanded leafroller (OBLR) Green fruitworm	• Movento 240 SC (23)	365 mL/ha	
	• Imidan 70-WP Instapak (1)	2.68 kg/ha	For overwintering OBLR, apply at petal fall. Spray in orchards with historical pest problems or high pest pressure (1–2% of the terminals or buds have larvae or damage). Place pheromone traps in orchards at petal fall to monitor summer-generation OBLR. OBLR are resistant to organophosphate insecticides in most commercial orchards. Cross-resistance to pyrethroids, Confirm and Intrepid is possible. See <i>Managing resistance to insecticides and miticides</i>, page 262. Success, Entrust, Delegate, Foray, Intrepid, Exirel: Not registered for green fruitworm. Dipel, Foray, Bioprotec: Make 2 applications at 5–7-day intervals if activity of the larvae is extended. For best results, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See <i>Using Organic and Biopesticide Products</i>, page 242. Altacor: Use 215 g/ha for green fruitworm control. Exirel: Apply at first egg hatch (170–240 DDC) after the first sustained moth catch. Re-apply 10 days later if emergence of larvae is extended. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Success (5)	182 mL/ha	
	• or Entrust SC (5)	364 mL/ha	
	• Delegate WG (5)	420 g/ha	
	• Dipel 2X DF (11)	1.125 kg/ha	
	• or Foray 48BA (11)	2.8 L/ha	
	• or Bioprotec CAF (11)	4 L/ha	
	• Intrepid 240 F (18)	750 mL/ha	
	• Altacor (28)	285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	
Pear rust mite	• Agri-Mek 1.9% EC (6)	0.75–1.5 L/ha	To control rust mite and prevent russetting fruit, apply a miticide at prebloom or petal fall. Agri-Mek: Do not use within 14 days of Supra Captan or Maestro. Apply no later than 21 days after petal fall for best results. Apply with 10 L oil and a minimum of 1,000 L of water per ha, when most mites are in the nymph stage. May cause russetting to d'Anjou and other sensitive varieties. Nexter: Controls all motile stages, not eggs. Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
	• Nexter (21)	300 g/ha	
	• Envidor 240 SC (23)	750 mL/ha	

Disease or Insect	Product (Group)	Rate	Comments
European red mite	• Agri-Mek 1.9% WC (6) • Apollo SC (10) • Kanemite 15 SC (20) • Nexter (21) • Envidor 240 SC (23)	0.75–1.5 L/ha 300 mL/ha 2.1 L/ha 300 g/ha 750 mL/ha	Agri-Mek: Do not use within 14 days of Supra Captan or Maestro. Apply no later than 21 days after petal fall for best results. Apply with 10 L oil and a minimum of 1,000 L of water per ha, when most mites are in the nymph stage. May cause russetting to d’Anjou and other sensitive varieties. Nexter: Controls all motile stages, not eggs. Envidor: Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Scab	Use one of the fungicides listed for scab at Green tip . If wet weather persists, additional sprays will be needed for scab control before first cover. Where there is a problem, spray at petal fall and first cover.		
Special spray (when monitoring indicates the need at Petal fall)			
Codling moth (first generation)	• Imidan 70-WP Instapak (1) • Assail 70 WP (4) • Calypso 480 SC (4) • Delegate WG (5) • Altacor (28) • Exirel (28)	2.68 kg/ha 170 g/ha 440 mL/ha 420 g/ha 215 g/ha 500–750 mL/ha	Timing is critical for effective control. Use pheromone traps to time sprays. Apply insecticides between 83–138 DDC (base 10°C) after first sustained moth catch. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Imidan: Apply at 138 DDC. Assail, Calypso: Apply 1–2 days earlier at (111–138 DDC) than Imidan. Residues last 10–14 days. Do not apply as a border spray. Altacor, Delegate: Apply at 138 DDC. Residues last 10–14 days. Do not apply as a border spray. Exirel: Monitor populations and reapply 10–14 days later if required. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
First cover			
Pear psylla	• Decis 5 EC (3) • Ripcord (3) • or Up-Cyde 2.5 EC (3) • Matador 120 EC (3) • or Silencer 120 EC (3) • Ambush 500 EC (3) • or Pounce 384 EC (3) • or Perm-Up (3) • Assail 70 WP (4) • Actara 25 WG (4) • Clutch 50 WDG (4) • Calypso 480 SC (4) • Agri-Mek 1.9% EC (6) • Nexter (21) • Surround WP (NC)	350 mL/ha 175 mL/ha 280 mL/ha 83 mL/ha 83 mL/ha 400 mL/ha 520 mL/ha 520 mL/ha 120 g/ha 385 g/ha 280–420 g/ha 290–440 mL/ha 1 L/ha 600 g/ha 50 kg/ha	Apply when the majority of the population is in early instar stages. Where plum curculio is a later-season problem, use one of the materials recommended at Petal fall. Decis, Ripcord, Up-Cyde, Matador, Silencer, Ambush, Pounce, Perm-Up: Resistance to these pyrethroid insecticides was widespread in the past and may still be present. Calypso: Apply high rate under high pressure. Apply when populations have reached economic thresholds. Re-apply at 7–10-day intervals if needed. Clutch: Make first application before populations reach damaging thresholds. If pest pressure continues, re-apply 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Agri-Mek: Apply no later than 21 days after petal fall. Apply with 10 L oil and a minimum of 1,000 L of water per ha. May cause russetting to d’Anjou and other sensitive varieties. Do not use oil within 14 days of Supra Captan or Maestro. Nexter: There is little commercial experience with this product for psylla. Surround: See <i>Using Organic and Biopesticide Products</i>, page 242.
Scab	Use one of the fungicides listed under Green tip . Reduce rate of Equal to 2.25 kg/ha and Sylitt to 3.65 L/ha in cover sprays. For additional fruit protection, tank-mix Nova or Inspire Super with the full rate of a protectant fungicide.		

Disease or Insect	Product (Group)	Rate	Comments
Special spray (when monitoring indicates the need at First cover)			
Blister mite	• Sevin XLR (7)	6.25 L/ha	
Summer sprays			
Pear psylla	Use one of the insecticides listed for pear psylla at First cover . Apply when majority of the population is in early instar stages. Do not exceed maximum number of applications for any product. See Table 6-9. <i>Products Used on Pears</i> , page 205.		
Obliquebanded leafroller (OBLR)	Use one of the insecticides listed for OBLR at Petal fall . Place pheromone traps in orchards by June to monitor adult populations. Insecticides for summer-generation larvae should be applied at 240–280 DDC (base 6.1°C) after first sustained moth catch. See Appendix B: <i>Degree-Day Modeling</i> , page 291. When applied for leafroller control, these products also control other leaf-feeding caterpillars. OBLR are resistant to organophosphate insecticides in most commercial apple orchards. Cross-resistance to pyrethroids, Confir and Intrepid is possible. See <i>Managing resistance to insecticides and miticides</i> , page 262.		
Mites	Use one of the miticides listed for pear rust mite and/or European red mite at Petal fall with the exception of Agri-Mek. Examine orchards for mite injury about July 15–20, or 10–15 days after using a pyrethroid. Kanemite : Not effective on rust mites.		
Second cover			
Oriental fruit moth (OFM)	• Decis 5 EC (3) • Assail 70 WP (4) • Calypso 480 SC (4) • Delegate WG (5) • Altacor (28) • Exirel (28)	250 mL/ha 240 g/ha 440 mL/ha 420 g/ha 215 g/ha 500–750 mL/ha	Apply within the appropriate degree-days (DDC, base 7.2°C) after sustained first-generation moth catch for best results. Monitor populations and re-apply 10–14 days later if required. See Appendix B: <i>Degree-Day Modeling</i> , page 291. Decis, Delegate, Altacor, Exirel : Apply at first egg hatch, 778–833 DDC. Assail, Calypso : Apply before first egg hatch, 750–778 DDC. Assail : Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Will also control plum curculio. Exirel : Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Scab	Use one of the fungicides listed for scab at Green tip . Reduce rate of Equal to 2.25 kg/ha and Sylitt to 3.65 L/ha in cover sprays. Check preharvest intervals on Table 6-9. <i>Products Used on Pears</i> , page 205.		
Special sprays (when monitoring indicates the need about mid-August and early September)			
Check preharvest interval before spraying early maturing pears. See Table 6-9. <i>Products Used on Pears</i> , page 205.			
Codling moth (second generation)	• Imidan 70-WP Instapak (1) • Assail 70 WP (4) • Delegate WG (5) • Altacor (28) • Exirel (28)	2.68 kg/ha 170 g/ha 420 g/ha 215 g/ha 500–750 mL/ha	Do not apply as a border spray. Codling moth can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require 2 preharvest sprays about 2 weeks apart. Timing is critical for effective control. Use pheromone traps to time sprays. For second-generation codling moth, spray at 611–694 DDC (base 10°C) after first-generation sustained moth catch. See Appendix B: <i>Degree-Day Modeling</i> , page 291. Imidan, Delegate, Altacor : Apply at 667–694 DDC. Assail : Apply 1–2 days earlier than Imidan (639–667 DDC). Assail residues last 10–14 days. Exirel : Timing of the first application is based on first egg hatch after establishing a new biofix. Monitor populations and re-apply 10–14 days later if required. Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Oriental fruit moth (OFM)	• Decis 5 EC (3) • Assail 70 WP (4) • Delegate WG (5) • Altacor (28) • Exirel (28)	250 mL/ha 240 g/ha 420 g/ha 215 g/ha 500–750 mL/ha	Apply within the appropriate degree-days (DDC, base 7.2°C) after sustained first-generation moth catch for best results. Monitor populations and re-apply 10–14 days later if required. See Appendix B: <i>Degree-Day Modeling</i> , page 291. A spray 7–10 days prior to harvest is recommended in orchards with a history of OFM damage or adjacent to or near peaches. Decis, Delegate, Altacor, Exirel : Apply at first egg hatch, 1,361–1,389 DDC. Assail : Apply before first egg hatch, 1,305–1,333 DDC. Exirel : Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.

Disease or Insect	Product (Group)	Rate	Comments
Brown marmorated stink bug	• Malathion 85 E (1)	1.22 L/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before insect populations reach damaging threshold. Malathion, Actara, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
	• Clutch 50 WDG (4)	210–420 g/ha	
	• Actara 25 WG (4)	385 g/ha	
Postharvest fruit treatment			
Blue mould	• Mertect SC (1)	500 mL/500 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. Mertect: For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould (<i>Penicillium</i>) or grey mould (<i>Botrytis</i>), which is resistant to benzimidazole fungicides (e.g., Benlate). Scholar: Scholar also controls grey mould. See label for dip and drench instructions. Bio-Save: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267, and <i>Using Organic and Biopesticide Products</i> , page 242.
	• Scholar 230 SC (12)	496 mL/378 L water	
	• Bio-Save 10 LP (NC)	50 g/300 L water	

Table 6-9. Products Used on Pears

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Actara 25 WG	28408	thiamethoxam	4A	60 days	12 hours	2
Agri-Mek 1.9% EC	24551	abamectin	6	28 days	12 hours	max. 1.5 L/ha
Altacor	28981	chlorantraniliprole	28	5 days	12 hours	3 (max. 645 g/ha)
Ambush 500 EC	14882	permethrin	3	7 days	when dried	—
Apollo SC	21035	clofentezine	10	21 days	12 hours	1
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ / 48 hours ² /6 days ³	4
Bioprotec CAF	26854	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Calypso 480 SC	28429	thiacloprid	4A	30 days	12 hours	3 (max. 875 mL/ha)
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)
Decis 5 EC	22478	deltamethrin	3	7 days	12 hours	3
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Entrust SC	30382	spinosad	5	7 days	when dried	3
Envior 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4
Foray 48BA	24978	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—
Imidan 70-WP Instapak	29064	phosmet	1B	14 days	7 days ^{1*} / 14 days ⁴ /30 days ⁵	5
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	2
Kanemite 15 SC	28641	acequinocyl	20B	14 days	12 hours	2
Malathion 85 E	8372	malathion	1B	3 days	12 hours	2
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	1
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.83 L/ha
Nexter	25135	pyridaben	21	25 days	24 hours	2
Perm-Up	28877	permethrin	3	7 days	12 hours	—
Pounce 384 EC	16688	permethrin	3	7 days	12 hours	—
Purespray Green Spray Oil 13E	27666	mineral oil	NC	—	12 hours	—
Ripcord	30316	cypermethrin	3	7 days	12 hours	2
Sevin XLR	27876	carbaryl	1A	11 days	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	1
Success	26835	spinosad	5	7 days	when dried	3

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.

² Hand labour and scouting activities.

³ Hand thinning.

⁴ Pick-your-own harvest.

⁵ Depends on rate. See label.

* Hand harvest.

⁶ Formerly Group 18.

* Personal protective equipment required for certain activities. See label.

Table 6-9. Products Used on Pears (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Superior 70 Oil	9542 14981	mineral oil	NC	prebloom	12 hours	—
Surround WP	27469	kaolin	NC	0 days	12 hours	—
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Products used for control or suppression of diseases						
Bio-Save 10 LP	29673	<i>Pseudomonas syringae</i>	NC	postharvest	—	—
Bloomtime Biological DF	28436	<i>Pantoea agglomerans</i>	NC	0 days	4 hours	2
Blossom Protect	30552	<i>Aurebasidium pullulans</i>	NC	—	when dried	5
Buran	30601	garlic powder	U	0 days	when dried	—
Copper 53 W	9934	basic copper sulphate	M	1 day	48 hours	2
Equal 65 WP	15608	dodine	U12	7 days	48 hours	2 ⁵
Flint	30619	trifloxystrobin	11	14 days	12 hours ¹ /4 days ³	4
Fontelis	30331	penthiopyrad	7	28 days	12 hours	max. 4.5 L/ha
Inspire Super	30827	difenoconazole + cyprodinil	3+9	14 days	12 hours	4
Kasumin 2L	20591	kasugamycin	24	90 days	12 hours	4
Maestro 80 DF	26408	captan	M	7 days	48 hours	—
Mertect SC	13975	thiabendazole	1	postharvest	—	—
Nova 40 W	22399	myclobutanil	3	14 days	when dried	6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	5 days	when dried ¹ / 5 days ⁶ /12 days ³	4
Scala SC	28011	pyrimethanil	9	72 days	12 hours ¹ /24 hours ³	4
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1
Serenade MAX	28549	<i>Bacillus subtilis</i>	44	0 days	12 hours	—
Sovran	26257	kresoxim-methyl	11	30 days	48 hours	4
Streptomycin 17	10305	streptomycin	25 ⁷	30 days	24 hours ¹ /7 days ⁷ / 14 days ¹	3
Supra Captan 80 WDG	24613	captan	M	7 days	48 hours	—
Syllit 400 FL	28351	dodine	U12	7 days	48 hours	2 ⁵

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. U = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ General re-entry.² Hand labour and scouting activities.³ Hand thinning.⁴ Pick-your-own harvest.⁵ Depends on rate. See label.⁶ Hand harvest.⁷ Formerly Group 18.^{*} Personal protective equipment required for certain activities. See label.

Thinning Pears

Like apple, thinning of pears will:

- improve average fruit size and finish
- create more uniformity in the crop
- encourage return bloom and annual bearing
- reduce limb breakage (on dwarfing rootstocks)

The objective of thinning is to reduce the number of fruit per spur, and to adequately space fruit. An additional benefit of thinning is reduced probability of pest damage. Some pests are more likely to damage clustered fruit. The thinning of fruit is particularly beneficial during seasons of heavy fruit set or inadequate moisture. Early thinning is important to obtain a high

percentage of marketable fruit and maximize return bloom the next year.

Determining how much thinning is required

The amount of thinning required depends on the age of the tree, the cultivar and the crop load. Traditionally young pear trees are defruited in the first 4 years of establishment to ensure adequate tree health and growth. In high-density pear orchards, fruit is completely removed in the first year, and approximately 3–4 fruit are left per tree in the second year. As the trees mature, an increasing number of fruit are left on the tree.

On mature trees, cultivars such as Bartlett and Bosc can set fruit in clusters of 3–5 fruit per spur. If overall crop load is heavy, reduce the number of fruit per cluster to 1 or 2. Some orchards have a tendency to be light in alternate years. In those orchards, spurs can carry more fruit when there are resting spurs on the tree. If the set on the tree is not excessive, 2–3 fruit per cluster will reach a satisfactory size without fruit thinning.

Methods of thinning in pear orchards

Chemical thinning

The response of pears to chemical thinners, under Ontario conditions, has been inconsistent between years. As a result, hand thinning alone is still most commonly used. However, increased labour costs and demand for larger-sized fruits have resulted in increased use of chemical thinners.

Try chemical thinning on a small scale in pear orchards until the response can be evaluated with respect to tree vigour, cultivar and fruit size. Some pear blocks can struggle to set adequate levels of fruit. It is best to assess pear set before applying chemical thinners, especially when conditions have been cool and/or wet during bloom.

The effectiveness of chemical thinners is highly dependent on weather conditions. Optimal weather conditions for the use of growth regulars include:

- cool wet weather and low light conditions before or after application
- prolonged period of high humidity without rain, either before or after application
- high temperatures after cool periods
- frost or near-freezing temperatures before or shortly after application

- prolonged period of dry weather before or after application
- excessively warm conditions following fruit set

A decrease in thinning response can result from sunny and warm daytime temperatures accompanied by relatively cool nighttime temperatures before and after thinning treatments have been applied. This results in a high net accumulation of carbohydrate reserves in the tree.

As with all plant growth regulators, complete coverage is essential for good results. Chemical thinners will act only where deposited. Sundown, Bartlett and Bosc are considered to be moderate to difficult to thin, while Anjou is considerably easier to thin.

Use either NAA (naphthaleneacetic acid) FRUITONE-N, or 6-BA (6-benzylaminopurine) Cilis Plus for chemical thinning. Suggested rates are: Fruitone-N at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or Cilis Plus at a rate of 100–150 ppm when fruitlets are 5–10 mm in diameter. For specific application instructions, consult the product label. See notes on NAA, page 67 and page 74. Note that carbaryl (Sevin XLR) should not be used on pears as it can cause misshapen fruit. Chemical thinning should be followed up with hand thinning where needed.

Hand thinning

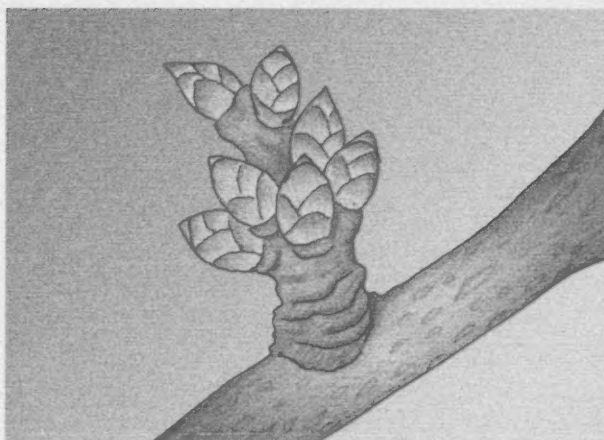
Start thinning near the end of June drop (mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning. Reduce the crop to 1 fruit per spur, spaced 12–15 cm apart during normal years. It is best to selectively remove smallest fruitlets when thinning.

Other tips on improving tree health and fruit size

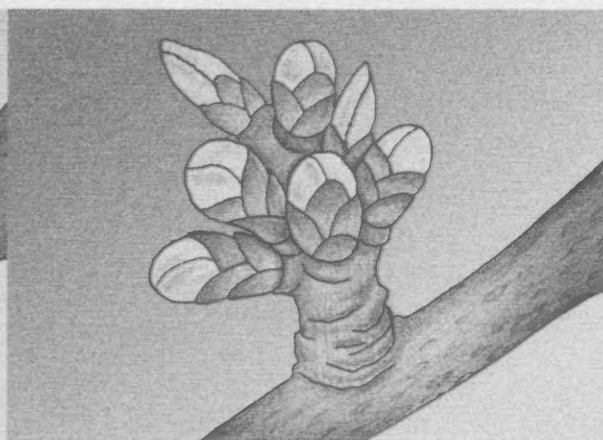
Consider spur pruning on older trees, especially for cultivars on dwarfing rootstock. These pear trees can “runt out” if allowed to bear too heavily in years 3–6. The combination of proper fruit thinning and irrigation has the most positive results on pear fruit size.

To obtain large-sized fruit, irrigate after fruit set, during extended dry periods in midsummer and a few weeks before harvest.

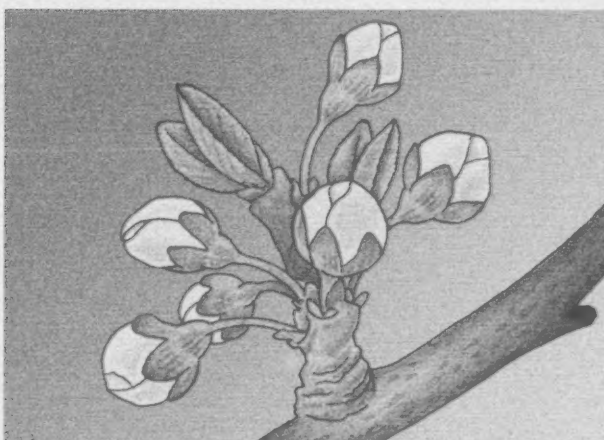
Figure 6-5. Plum and Prune Growth Stages



Dormant



Green Tip



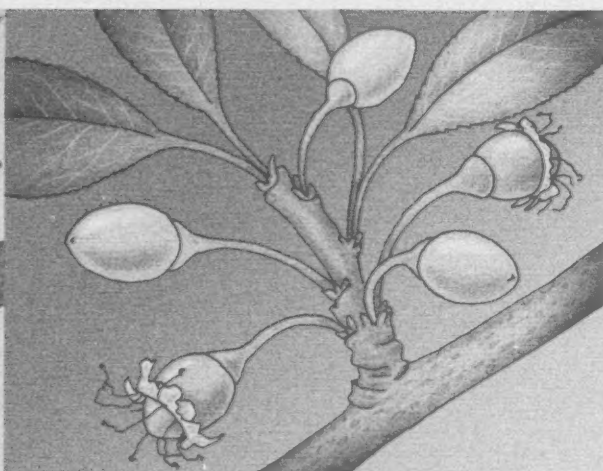
Popcorn



Bloom



Petal Fall



Shuck Fall

Plum Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period and maximum number of applications, see Table 6-10. *Products Used on Plums*, page 213.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.
- Do not use Topas, Indar, Jade, Funginex, Mission, Fontelis, Cantus, Pristine, Rovral or Senator when sporulating lesions of target disease are present.

Insecticide resistance management

In addition, take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (oriental fruit moth, borers, obliquebanded leafroller), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to plums during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Dormant (before bud break)			
Black knot	Prune out all black knots from commercial orchards during the dormant period before bud break. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Destroy infected wild and neglected plums near the orchard.		
Green tip (just as buds are bursting)			
European red mite	• Superior 70 Oil (NC)	20 L/1,000 L water	Spray on a calm day to improve coverage.
Scale insects	• Purespray Green Spray Oil 13E (NC)	20 L/1,000 L water	

Disease or Insect	Product (Group)	Rate	Comments
Popcorn (when blossoms show white)			
Brown rot (Blossom blight stage)	• Senator 70WP (1)	1.75 kg/ha	Knock off fruit mummies when pruning. Cultivate entire orchard before bloom. Make 2–3 fungicide applications from early to full bloom. These products are locally systemic and will penetrate petals to protect fruit from infection as blossoms start to open. Consult labels for information on drying time required before rain.
	• Rovral WDG (2)	1.5 kg/ha	
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	
	• Indar (3)	140 g/ha	
	• Funginex DC (3)	2.5 L/ha	
	• Cantus WDG (7)	370 g/ha	
	• Fontelis (7)	1.0–1.75 L/ha	
Black knot	• Pristine WG (7+11)	750 g/ha	Fungicides will not provide adequate control of black knot without proper orchard sanitation (pruning, removal and burning of black knots). Inspect all plums in early summer. Cut out and burn new knots and those missed. European plums, prunes and Damsons are most susceptible. Apply fungicide sprays to protect the developing shoots between the popcorn stage (prebloom) and first cover every 3–5 days in wet weather. Spore release may be delayed in dry springs. Under these conditions extend fungicide coverage to Second cover. Topas, Jade, Mission: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings, page 267.</i>
	• Vanguard 75 WG (9)	370 g/ha	
	• Supra Captan 80 WDG (M)	4.5 kg/ha	
	• or Maestro 80 DF (M)	4.5 kg/ha	
	• Indar (3)	140 g/ha	
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	

Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.

Bloom

DO NOT APPLY INSECTICIDES WHILE PLUM TREES ARE IN BLOOM. SEE BEE POISONING, PAGE 269.

Brown rot (Blossom blight stage) Use one of the fungicides listed for brown rot at **Popcorn**.

Shuck fall (when most of the shucks are off)

Brown rot	• Microscopic Sulphur (M)	19.5 kg/ha	Supra Captan, Maestro: May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under slow drying conditions. Topas, Jade, Mission, Indar, Cantus, Fontelis, Pristine, Vanguard: These products are locally systemic. Consult labels for information on drying time required before rain.
	• or Microthiol Dispers (M)	22.5 kg/ha	
	• or Kumulus DF (M)	22.5 kg/ha	
	• Supra Captan 80 WDG (M)	22.5 kg/ha 4.5 kg/ha	
	• or Maestro 80 DF (M)	4.5 kg/ha	
	• Topas (3)	500 mL/ha	
	• or Jade (3)	500 mL/ha	
	• or Mission 418 EC (3)	300 mL/ha	
	• Indar (3)	140 g/ha	
	• Cantus WDG (7)	370 g/ha	
Black knot	• Fontelis (7)	1.0–1.75 L/ha	Use one of the fungicides listed for black knot at Popcorn. Supra Captan, Maestro: May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under slow drying conditions.
	• Pristine WG (7+11)	750 g/ha	
	• Vanguard 75 WG (9)	740 g/ha	

Disease or Insect	Product (Group)	Rate	Comments
Oriental fruit moth (OFM)	• Assail 70 WP (4)	120–240 g/ha	Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. Apply within the specified degree-day (DDC, base 7.2°C) after sustained moth catch in pheromone traps. Re-apply 10–14 days later if catch is extended. Assail, Intrepid: Apply at 100–140 DDC. Delegate, Altacor, Exirel: Apply at 194–208 DDC. Rimon: Apply at 111–139 DDC. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Assail: For optimum activity, use 240 g/ha in a minimum of 1,000 L water/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Delegate WG (5)	420 g/ha	
	• Rimon 10 EC (15)	1.35–3.35 L/ha	
	• Intrepid 240 F (18)	1.5 L/ha	
	• Altacor (28)	285 g/ha	
	• Exirel (28)	500–750 mL/ha	
Plum curculio	• Imidan 70-WP Instapak (1)	2.68 kg/ha	Silencer, Pounce, Up-Cyde, Perm-Up, Assail: Under high insect pressure, may provide suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Clutch: If applied at the appropriate timing and at 420 g/ha, Clutch may provide suppression of oriental fruit moth. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
	• Silencer 120 EC (3)	104 mL/ha	
	• Pounce 384 EC (3)	520 mL/ha	
	• or Perm-Up (3)	520 mL/ha	
	• Up-Cyde 2.5 EC (3)	400 mL/ha	
	• Assail 70 WP (4)	240 g/ha	
	• Clutch 50 WDG (4)	210 g/ha	
Peachtree borer Lesser peachtree borer	• Exirel (28)	1.0–1.5 L/ha	
	• Isomate-PTB Dual	375–675 dispensers/ha	Reduces mating of peachtree borers. Apply before borer flight begins in the spring, i.e., typically apply at or before shuck split. Apply at least 375 dispensers per ha for low-pressure sites and up to 675 dispensers per ha for high-pressure sites. Insecticides for peachtree borer may be needed as long as the maximum labelled use rate is not exceeded in the course of the season. Populations are generally reduced over time where mating disruption is used for several seasons. For more information, see <i>Mating Disruption in Fruit Crops</i>, page 250.
First cover (12 days after Shuck fall)			
Brown rot Black knot	Use one of the fungicides listed for brown rot and black knot under Shuck fall. Black knot spore release may be delayed in dry springs. Under these conditions extend fungicide coverage for black knot to Second cover. Captan, Maestro: May cause leaf injury and spotting on the fruit of Stanley and Japanese plums.		
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck fall .		

Disease or Insect	Product (Group)	Rate	Comments
Second cover			
Check preharvest interval before spraying early maturing plums. See Table 6-10. <i>Products Used on Plums</i> , page 213.			
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall . During wet weather, repeat applications between pickings. Comply with preharvest intervals in Table 6-10. <i>Products Used on Plums</i> , page 213. Topas, Jade, Mission: No more than 2 applications in the 3 weeks prior to harvest.		
Oriental fruit moth (OFM)	- Assail 70 WP (4) - Delegate WG (5) - Rimon 10 EC (15) - Altacor (28) - Exirel (28)	120–240 g/ha 420 g/ha 1.35–3.35 L/ha 215–285 g/ha 500–750 mL/ha	If mating disruption for OFM is being used, a pesticide application is not required for second generation OFM. Spray all varieties. This generation may require 2 insecticide sprays. Apply within the specified degree-day (DDC, base 7.2°C) after sustained first-generation moth catch in pheromone traps. Check the harvest dates of early varieties and do not spray within the preharvest interval. For second-generation OFM, use the following timings: Assail: Apply at 583–611 DDC and again at 750–778 DDC. Delegate, Altacor, Exirel: Apply at 639–667 DDC and again at 805–833 DDC. Rimon: Apply at 555–583 DDC and again at 722–750 DDC. For third-generation OFM, use the following timings: Assail: Apply at 1,111–1,167 DDC and again at 1,305–1,389 DDC. Delegate, Altacor, Exirel: Apply at 1,167–1,222 and again at 1,361–1,389 DDC. Rimon: Apply at 1,083–1,139 and again at 1,277–1,305 DDC. See Appendix B: <i>Degree-Day Modeling</i>, page 291. Assail: For optimum activity, use 240 g/ha in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Prepick			
Check preharvest interval before. See Table 6-10. <i>Products Used on Plums</i> , page 213.			
Brown rot	Use one of the fungicides listed for brown rot at Shuck fall .		
Oriental fruit moth	Use one of the insecticides listed for oriental fruit moth at Second cover .		
Special sprays (when monitoring indicates the need)			
Aphids	- Clutch 50 WDG (4) - Admire 240 F (4) - Closer SC (4) - Beleaf 50 SG (9) - Movento 240 SC (23) - Exirel (28) - Purespray Green Spray Oil 13E (NC)	140–210 g/ha 230 mL/ha 100–200 mL/ha 120–160 g/ha 365 mL/ha 0.75–1.0 L/ha 10 L/1,000 L water	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control. Admire: Apply in a minimum spray volume of 500 L/ha. Closer: Registered for green peach aphid. Movento: Most effective on young stages of aphids. Control may not be apparent for 2–3 weeks. Under high pressure, a second application may be necessary 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides. Purespray Green Spray Oil 13E: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267 not been determined for all varieties; test a small area of each variety prior to spraying the whole field. Do not apply within 14 days of Supra Captan or Maestro, or products containing sulphur. Do not apply within 48 hours of freezing temperatures, when temperatures are high (above 25°C), to crops under moisture stress, or just prior to rain. Read the label carefully for other precautions. See <i>Using Organic and Biopesticide Products</i>, page 242.

Disease or Insect	Product (Group)	Rate	Comments
Peachtree borer	• Sevin XLR (1)	6.25 L/ha	Direct sprays with a handgun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period. Sevin: For lesser peachtree borer only. Sevin, Thionex: Apply 3 sprays at a 3-week interval starting 10 days after first trap catch. Rimon: Apply at 3-week interval starting 7–10 days after first trap catch.
Lesser peachtree borer	• Thionex 50 WSP (2)	1.5 kg/1,000 L water	
	• Rimon 10 EC (15)	1.4 L/1,000 L water	
Obliquebanded leafroller (OBLR)	• Success (5) or Entrust SC (5) • Delegate WG (5) • Rimon 10 EC (15) • Altacor (28)	182 mL/ha 364 mL/ha 420 g/ha 1.35–3.35 L/ha 285 g/ha	For OBLR summer generations, apply at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch).
Japanese beetle	• Imidan 70-WP Instapak (1) • Altacor (28) • Exirel (28)	2.68 kg/ha 285 g/ha 1.0–1.5 L/ha	Altacor: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Exirel: Do not tank-mix or make sequential applications with strobilurins, copper or captan fungicides.
Brown marmorated stink bug	• Malathion 85 E (1) • Clutch 50 WDG (4)	880 mL/ha 210–420 g/ha	At time of printing this publication, this pest has not been detected in orchards, but breeding populations are present in Ontario. Check the OMAF website at www.ontario.ca/stinkbug for updates on pest development, registered products and management strategies for control. Apply before insect populations reach damaging threshold. Malathion, Clutch: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC (12)	496 mL/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. Scholar: Should not be used on plums intended for processing into prunes.

Table 6-10. Products Used on Plums

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	2
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3 (max. 645 g/ha)
Assail 70 WP	27128	acetamiprid	4A	7 days	12 hours ¹ /6 days ²	4
Beleaf 50 SG	29796	flonicamid	9C	14 days	12 hours ¹ / 48 hours ²	3
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2 (max. 420 g/ha)

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. — = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pick-your-own harvest.

⁴ No more than 2 applications in the 3 weeks prior to harvest.

⁵ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Table 6-10. Products Used on Plums (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Entrust SC	30382	spinosad	5	7 days	when dried	3
Exirel	30895	cyantraniliprole	28	3 days	12 hours	4
Imidan 70-WP Instapak	29064	phosmet	1B	14 days	7 days ¹ /14 days ¹ / 30 days ²	3
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	1
Malathion 85 E	8372	malathion	1B	3 days	12 hours	2
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 1.12 L/ha
Perm-Up	28877	permethrin	3	7 days	12 hours	—
Pounce 384 EC	16688	permethrin	3	7 days	when dried	—
Purespray Green Spray Oil 13E	27666	mineral oil	NC	—	12 hours	—
Rimon 10 EC	28881 28515	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days	12 hours	—
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success	26835	spinosad	5	7 days	when dried	3
Superior 70 Oil	9542 14981	mineral oil	NC	prebloom	12 hours	—
Thionex 50 WSP	29990	endosulfan	2A	18 days	7 days ³ /20 days ²	3
Up-Cycle 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Products used for control or suppression of diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Fontelis	30331	penthiopyrad	7	0 days	12 hours	max. 4.5 L/ha
Funginex DC	27686	triforine	3	prebloom	48 hours	3
Indar	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5 ⁴
Maestro 80 DF	26408	captan	M	2 days	48 hours	—
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5 ⁴
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	when dried ¹ / 24 hours ² /10 days ²	5
Rovral WDG	24709	iprodione	2	1 day	12 hours	—
Scholar 230 SC	29528	fludioxonil	12	postharvest	—	1
Senator 70 WP	25343	thiophanate-methyl	1	1 day	12 hours	—
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	—
Topas	30163	propiconazole	3	3 days	72 hours	5 ⁴
Vanguard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. — = Information is not specified on the product label.

¹ General re-entry.

² Hand thinning.

³ Pick-your-own harvest.

⁴ No more than 2 applications in the 3 weeks prior to harvest.

⁵ Hand harvest.

* Personal protective equipment required for certain activities. See label.

Notes on Plums

Heat spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after a period of hot weather. Summer cover crops and mulch help to reduce this physiological condition.

To reduce this disorder on prunes, spray with 4 kg of calcium chloride in 1,000 L of water during the period from early July to mid-August. Apply 3 sprays, 10–12 days apart. See notes on *Calcium (Ca)*, page 164.

Thinning Plums

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic fruit thinning; otherwise, fruit size will be small and biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning results in production of under-sized plums and, at times, fruit ripening on overloaded trees will be delayed. Irrigation is important to obtain large-sized fruit. See notes on irrigation under *Thinning Peaches*, page 195. Start thinning near the end of June drop in early to mid-June when it can be determined which fruit will abort naturally. Thinning at early fruit development has more benefits than late thinning. Chemical thinners do not work on plums, so hand thinning is necessary.

Fruit-size thinning is preferred to conventional-space thinning. Size thinning selectively removes small, weak, blemished or diseased fruit regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

Notes on Fungicides, Insecticides and Miticides for Tender Fruit

For information on the activity of fungicides on tender fruit diseases, see Table 6-11. *Activity of Fungicides on Tender Fruit Diseases*, on this page.

For information on the activity of insecticides on tender fruit insects, see Table 6-12. *Activity of Insecticides and Miticides on Tender Fruit Pests*, page 217.

Table 6-11. Activity of Fungicides on Tender Fruit Diseases

Use fungicides only for diseases listed on the product label for the crop. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best fungicide for control of diseases listed on the product label, while managing resistance and avoiding unnecessary sprays. Efficacy can be affected by rate of the product.

Group	Product name	Brown rot blossom blight	Brown rot fruit phase	Peach scab	Peach leaf curl	Bacterial canker/spot	Powdery mildew	Rhizopus rot	Cherry leaf spot	Black knot	Pear scab	Registered for use on:				
												Apricots	Cherries	Peaches	Plums	Pears
M	Copper Spray	1*	1*	0	2*	2*	0	0	1*	0	1	NR	✓	✓	NR	NR
M	Guardman Copper Oxychloride 50	0	0	0	2*	2*	0	0	1*	0	1	NR	✓	✓	NR	NR
M	Kumulus DF	2*	1*	3*	0	—	2*	0	1	1	1*	NR	✓	✓	✓	✓
M	Microscopic Sulphur	2*	1*	3*	0	0	2*	0	1	1*	1*	NR	✓	✓	✓	✓
M	Microthiol Dispers	2*	1*	3*	0	0	2*	0	1	1	1*	NR	✓	✓	✓	✓
M	Ferbam 76 WDG	0*	0*	—	4*	0	0	NA	2*	0	1*	✓	✓	✓	✓	✓
M	Granuflo-T	3*	3*	3*	3	0	0	0	—	—	—	NR	NR	✓	✓	NR
M	Thiram 75 WP	3*	3*	3*	3	0	0	0	—	—	—	NR	NR	✓	✓	NR
M	Supra Captan 80 WDG	3*	3*	4*	2	0	0	1	3*	2*	3*	✓	✓	✓	✓	✓
M	Maestro 80 DF	3*	3*	4*	2	0	0	1	3*	2*	3*	✓	✓	✓	✓	✓
M	Bravo 500	3*	NA	4	4*	0	0	0	4*	4*	—	NR	✓	✓	NR	NR
M	Echo 720	3*	NA	4	4*	0	0	0	4*	4*	—	NR	✓	✓	NR	NR
NC	Purespray Green Spray Oil 13E	0	0	0	0	0	3*	0	0	0	0	✓	✓	✓	✓	✓
1	Senator 70 WP	3*	3*	—	2	0	3	—	3	—	2	NR	✓	✓	✓	✓
2	Rovral WDG	4*	4*	0	0	0	0	2	2	0	—	✓	✓	✓	✓	NR
3	Funginex DC	3*	NA	0	0	0	3	—	3	0	—	NR	✓	✓	✓	NR
3	Indar	4*	4*	3	0	0	3	0	3	2*	—	✓	✓	✓	✓	NR
3	Jade	4*	4*	3	0	0	3	4	3*	1*	—	✓	✓	✓	✓	✓
3	Nova 40 W	3*	NA	—	0	0	4*	0	3*	0	3	NR	✓	✓	NR	✓
3	Topas	4*	4*	3	0	0	3	4	3*	1*	—	✓	✓	✓	✓	NR
3	Mission 418 EC	4*	4*	3	0	0	3	4	3*	1*	—	✓	✓	✓	✓	NR
3+9	Inspire Super	—	—	—	—	—	—	—	—	—	3*	NR	NR	NR	NR	✓
7	Cantus WDG	4*	4*	—	0	NA	2	0	—	—	NA	✓	✓	✓	✓	NR
7	Fontelis	4*	4*	4*	0	0	2*	0	1*	—	3*	✓	✓	✓	✓	✓
7+11	Pristine WG	4*	4*	4	0	NA	2*	4*	4*	—	3*	✓	✓	✓	✓	✓
9	Vangard 75 WG	4*	4*	—	0	0	0	3	0	0	NA	✓	NR	✓	✓	NR

0 = Not effective. 1 = Slightly effective/suppression. 2 = Fair. 3 = Good. 4 = Very good. NA = Not used at this timing for this pest. — = No information is available.

✓ Registered on the crop, but not necessarily for all diseases. NR = Not registered for use on this crop.

*(shaded area) = Pest is listed on the product label for control or suppression.

Source: Various US extension publications, scientific journal articles, Canadian Pest Management Research Reports and Plant Disease Management Reports (APS).

Table 6-11. Activity of Fungicides on Tender Fruit Diseases (cont'd)

Group	Product name	Brown rot blossom blight	Brown rot fruit phase	Peach scab	Peach leaf curl	Bacterial canker/spot	Powdery mildew	Rhizopus rot	Cherry leaf spot	Black knot	Pear scab	Registered for use on:				
												Apricots	Cherries	Peaches	Plums	Pears
9	Scala SC	4*	4*	0	0	0	0	0	0	0	2	NR	NR	NR	✓	✓
11	Flint	0	0	0	0	0	1*	0	4*	0	3*	✓	✓	✓	✓	✓
11	Sovran	—	—	—	—	—	—	—	—	—	3*	NR	NR	NR	NR	✓
11	Cabrio EG	1*	1	1	0	0	4*	4	4	—	—	✓	✓	✓	✓	NR
12	Scholar 230 SC	NA	4*	NA	NA	NA	NA	4*	NA	NA	NA	✓	✓	✓	✓	✓
13	Quintec	0	0	0	0	0	4*	0	0	0	0	✓	✓	✓	✓	NR
17	Elevate 50 WDG	4*	4*	0	0	0	0	0	0	0	—	NR	✓	✓	NR	NR
U	Buran	—	—	—	—	—	—	—	—	—	—*	NR	NR	NR	NR	✓
U12	Equal 65 WP	—	—	—	NA	—	—	—	3*	—	3*	NR	✓	NR	NR	✓
U12	Syllit 400 FL	—	—	—	NA	—	—	—	3	—	3*	NR	NR	NR	NR	✓

0 = Not effective. 1 = Slightly effective/suppression. 2 = Fair. 3 = Good. 4 = Very good. NA = Not used at this timing for this pest. — = No information is available.

✓ Registered on the crop, but not necessarily for all diseases. NR = Not registered for use on this crop.

*(shaded area) = Pest is listed on the product label for control or suppression.

Source: Various US extension publications, scientific journal articles, Canadian Pest Management Research Reports and Plant Disease Management Reports (APS).

Table 6-12. Activity of Insecticides and Miticides on Tender Fruit Pests

Use insecticides only for insects listed on the product label for the crop and for the insect. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Product name	Oriental fruit moth	Plum curculio	Tarnished plant bug	Oblique banded leafroller	Japanese beetle	Aphids	Cherry fruit fly	Mites	Pear psylla	Codling moth	Registered for use on:				
											Apricots	Cherries	Peaches	Plums	Pears
Actara 25 WG	0	3*	3	0	1	3*	0	0	4*	0	NR	✓	NR	NR	✓
Admire 240 F	0	0	1	0	1	3*	3*	0	0	—	✓	✓	✓	✓	✓
Agri-Mek 1.9% EC	0	0	0	0	0	0	—	4*	4*	0	NR	NR	NR	NR	✓
Altacor	4*	1	1	4*	1*	0	0*	0	0	4*	✓	✓	✓	✓	✓
Ambush 500 EC	4*	2*	3*	4	3	0	2	0	3*	2*	NR	NR	✓	✓	✓
Apollo SC	0	0	0	0	0	0	0	3* E	0	0	NR	NR	✓	NR	✓
Assail 70 WP	4*	1 to 2*	2	1	2	4	1*	0	3*	3*	✓	✓	✓	✓	✓
Beleaf 50 SG	0	0	2	0	0	3*	0	0	0	0	✓	✓	✓	✓	✓
Bioprotec CAF	1	0	0	3*	0	0	0	0	0	1	✓	✓	✓	✓	✓
Calypso 480 SC	3*	3*	3	—	—	—	—	0	3*	3*	NR	NR	NR	NR	✓
Closer SC	0	0	0	0	0	3*	0	0	0	0	✓	✓	✓	✓	✓
Clutch 50 WDG	3*	3*	—	—	2	4*	—	0	3*	1*	✓	✓	✓	✓	✓
Decis 5 EC	3*	1	3	3	0	1	—	0	4*	3	NR	NR	✓	NR	✓

0 = Not effective. 1 = Slightly effective/suppression. 2 = Fair. 3 = Good. 4 = Very good. NA = Not used at this timing for this pest. — = No information is available.

R = Resistance detected in Ontario. early = Early season application. 1st = First generation only. gpa = Green peach aphid. bca = Black cherry aphid.

ow = Overwintering generation.

✓ Registered on the crop, but not necessarily for all diseases. NR = Not registered for use on this crop. s = Sour cherry only.

*(shaded area) = Pest is listed on the product label for control or suppression.

Source: Various US extension publications, scientific journal articles, Canadian Pest Management Research Reports, Arthropod Management Reports (ESA).

Table 6-12. Activity of Insecticides and Miticides on Tender Fruit Pests (cont'd)

Product name	Oriental fruit moth	Plum curculio	Tarnished plant bug	Oblique banded leafroller	Japanese beetle	Aphids	Cherry fruit fly	Mites	Pear psylla	Codling moth	Registered for use on:				
											Apricots	Cherries	Peaches	Plums	Pears
Delegate WG	4*	2*	0	4*	0	0	0	0	3	3*	✓	✓	✓	✓	✓
Diazinon 50 WSP	4	2	2	2	2	2*	2*	2*	2	2	NR	✓	NR	NR	✓
Dipel 2X DF	1	0	0	3*	0	0	0	0	0	1	✓	✓	NR	✓	✓
Entrust SC	1	0	0	3*	0	0	3*	0	0	1	✓	✓	✓	✓	✓
Envior 240 SC	0	0	0	0	0	0	0	4*	0	0	✓	✓	✓	✓	✓
Exirel	4*	4*	3	4*	3*	3*	3*	0	—	3*	✓	✓	✓	✓	✓
Foray 48 BA	0	0	0	3* E	0	0	0	0	0	0	NR	NR	NR	NR	✓
GF-120 Fruit Fly Bait	—	0	0	0	0	0	3*	0	—	—	NR	✓	NR	NR	NR
Imidan 70-WP Instapak	2*	4*	2*	2*	3*	1	2*	1*	1	3* R	NR	✓ _s	✓	✓	✓
Intrepid 240 F	3* 1st	0	0	3*	0	0	0	0	0	1	✓	✓	✓	✓	✓
Kanemite 15 SC	0	0	0	0	0	0	0	4*	0	0	NR	NR	NR	NR	✓
Lorsban 50 W	2 1st	—	4	—	—	—	—	0	—	—	NR	NR	✓	NR	NR
Matador 120 EC	3*	2*	3*	3	3	3*	2*	0	2*	3*	NR	✓	✓	✓	✓
Movento 240 SC	0	0	0	0	0	4*	0	0	4*	0	✓	✓	✓	✓	✓
Nexter	0	0	0	0	0	0	0	3 to 4*	2*	0	NR	✓	✓	NR	✓
Perm-Up	4*	2*	2*	4	3	2	—	0	3*	3*	NR	NR	✓	✓	✓
Pounce 384 EC	4*	2*	2*	4	3	2	—	0	3*	3*	NR	NR	✓	✓	✓
Purespray Green Spray Oil 13E	0	0	0	0	0	2*	0	4*	0	0	✓	✓	✓	✓	✓
Rimon 10 EC	4*	0	4	4*	0	0	0	0	—	—	✓	✓	✓	✓	NR
Ripcord	3*	3*	3*	—	—	2	2	0	3*	2*	NR	NR	✓	NR	✓
Sevin XLR	3*	2*	2	1	4	2* bca	2*	0	2*	2*	✓	✓	✓	✓	✓
Silencer 120 EC	3*	3*	3*	4	3	2* gpa	2*	0	3*	3*	NR	✓	✓	✓	✓
Success	1	0	0	3*	0	0	3	0	0	1	✓	✓	✓	✓	✓
Superior 70 Oil	0	0	0	0	0	0	0	4*	2*	0	✓	✓ _s	✓	✓	✓
Surround WP	1*	2*	2*	2* ow	1	0	—	0	2*	1* 1st	NR	NR	NR	NR	✓
Thionex 50 WSP	—	—	2*	—	—	2* bca	—	—	3	2	✓	✓	✓	✓	NR
Up-Cyde 2.5 EC	3*	3*	3*	4	3	—	2	—	3	3	NR	NR	✓	✓	✓

0 = Not effective. 1 = Slightly effective/suppression. 2 = Fair. 3 = Good. 4 = Very good. NA = Not used at this timing for this pest. — = No information is available.
 R = Resistance detected in Ontario. early = Early season application. 1st = First generation only. gpa = Green peach aphid. bca = Black cherry aphid.
 ow = Overwintering generation.

✓ Registered on the crop, but not necessarily for all diseases. NR = Not registered for use on this crop. s = Sour cherry only.

*(shaded area) = Pest is listed on the product label for control or suppression.

Source: Various US extension publications, scientific journal articles, Canadian Pest Management Research Reports, Arthropod Management Reports (ESA).

7. Tree Nuts

Walnut Calendar

Read the label and follow all safety precautions.

For preharvest interval, re-entry period, and maximum number of applications, see Table 7-1. *Products Used on Tree Nuts*, page 228.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (leafroller, codling moth), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Spray Water Volumes

Thorough coverage of all affected plant surfaces is essential for maximum efficacy of many tree nut products. Sufficient water volumes are necessary to provide complete coverage with insecticides, miticides and fungicides. Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, or if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to tree nuts during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Prebloom			
Leafrollers	• Delegate WG (5)	210–420 g/ha	Apply when larvae have emerged and before they roll up in the leaves. Re-apply in 1–2 weeks, if needed. Dipel: Use 1.6 kg/ha for large or mature trees. See <i>Using Organic and Biopesticide Products</i>, page 242. Exirel: Do not tank-mix or make sequential applications with copper products. Surround: Reduction in damage only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Make a second application 10 days later. Repeat at 7–14-day intervals as subsequent generations emerge. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Entrust 80 W (5)	109 g/ha	
	• Dipel 2X DF (11)	1.12 kg/ha	
	• Intrepid 240 F (18)	750 mL/ha	
	• Altacor (28)	145–285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	
	• Surround WP (NC)	50 kg/ha	
Codling moth	• Delegate WG (5)	420 g/ha	Codling moth is a sporadic problem in commercial walnuts. Control may not always be required. Degree-day models for apples may help with timing. Delegate, Entrust: Entrust provides suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Apply at first egg hatch, before larvae penetrate nuts. Reapply in 14 days (Delegate) or 7–10 days (Entrust) if needed. Altacor, Exirel: Apply before first egg hatch. Reapply 10–14 days later if needed. Use high rate under high pressure. Do not tank-mix or make sequential applications of Exirel with copper products. Isomate-CM/OFM TT: Reduces mating of codling moth. Apply prior to emergence in the spring. See <i>Mating Disruption in Fruit Crops</i>, page 250.
	• Entrust 80 W (5)	109 g/ha	
	• Altacor (28)	145–215 g/ha	
	• Exirel (28)	500–750 mL/ha	
	• Isomate-CM/OFM TT	750 dispensers/ha	
Aphids	• Closer SC (4)	100–200 mL/ha	For best results, apply in early stages of aphid infestation. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Scale	• Closer SC (4)	200–400 mL/ha	Monitor scaffold branches and apply when crawlers are active. Closer: For control of San Jose scale. Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Mites	• Kanemite 15 SC (20)	2.07 L/ha	Apply when mites are active on foliage. Thorough spray coverage is essential for good control. Kanemite: Maximum of 1 application per season. Acramite: Rate controls two-spotted spider mite. If European red mite is present, apply 851 g/ha. Maximum of 1 application per season. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Acramite 50 WS (UN)	568 g/ha	
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Dogwood borer	• Isomate DWB	250–375 dispensers/ha	Dogwood borer is not commonly a pest of tree nuts. Apply where there is a history of infestation. Reduces mating of dogwood borer. Apply before adult borer emergence (end of May). Use high rate for high pressure areas or initial year of treatment. See <i>Mating Disruption in Fruit Crops</i> page 250.
Walnut blight	• Copper Spray (M)	4 kg/1,000 L water	Copper: Apply at first pistillate, or late May and repeat monthly if needed. Kasumin: Apply when conditions favour disease development.
	• Kasumin 2L (24)	5 L/ha	

Disease or insect	Product (Group)	Rate	Comments
First pistillate flower			
INSECTICIDES MAY BE TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE BEE POISONING, PAGE 269.			
Aphids	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Scale	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	For control of soft brown scale. Apply when crawlers are active. Re-apply every 1–3 weeks as needed. Maximum of 3 application per season. Avoid application in direct sunlight.
Butternut curculio	• Surround WP (NC)	50 kg/ha	Apply when visual inspection shows adult feeding and egg-laying scars on new flower shoots. See <i>Using Organic and Biopesticide Products</i> , page 242.
Walnut blight	Use one of the products listed for walnut blight at Prebloom .		
Summer sprays			
Leafroller	• Delegate WG (5) • Entrust 80 W (5) • Dipel 2X DF (11) • Intrepid 240 F (18) • Altacor (28) • Exirel (28) • Surround WP (NC)	210–420 g/ha 109 g/ha 1.12 kg/ha 750 mL/ha 145–285 g/ha 0.5–1.0 L/ha 50 kg/ha	Degree-day models for apples may help with timing. Delegate, Entrust: Apply at first egg hatch. Dipel: Apply when small larvae are present. Use 1.6 kg/ha for large or mature trees. See <i>Using Organic and Biopesticide Products</i> , page 242. Intrepid: Apply at first egg hatch. Re-apply 10–14 days later if needed Altacor, Exirel: Apply at first egg hatch. Re-apply 10 days later if needed. Do not tank-mix or make sequential applications of Exirel with copper products. Surround: Reduction in damage only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply at first egg hatch. Make a second application 10 days later. Repeat at 7–14-day intervals as subsequent generations emerge. See <i>Using Organic and Biopesticide Products</i> , page 242.
Codling moth	• Delegate WG (5) • Entrust 80 W (5) • Intrepid 240 F (18) • Altacor (28) • Exirel (28)	420 g/ha 109 g/ha 1.0 L/ha 145–215 g/ha 500–750 mL/ha	Degree-day models for apples may help with timing. Delegate, Entrust: Entrust provides suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply at first egg hatch, before larvae penetrate nuts. Re-apply in 14 days (Delegate) or 7–10 days (Entrust) depending on pest pressure. Intrepid: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply at first egg hatch and repeat in 10–14 days if required. Altacor, Exirel: Apply at first egg hatch. Use high rate under high pressure. Re-apply 10–14 days later if needed. Do not tank-mix or make sequential applications of Exirel with copper products.
Aphids	• Admire 240 F (4) • Closer SC (4) • Movento 240 SC (23) • Opal (NC)	230 mL/ha 100–200 mL/ha 365 mL/ha 14 L/700 L water– 38 L/1,900 L water	For best results, apply in early stages of aphid infestation. Some of these products are toxic to bees. Do not apply when bees are active on flowering weeds or other crops in the treatment area. Refer to label for specific bee toxicity statements. Admire, Movento: Use postbloom only. Movento: Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.

Disease or Insect	Product (Group)	Rate	Comments
Scale	• Closer SC (4) • Movento 240 SC (23) • Opal (NC)	200–400 mL/ha 585 mL/ha 14 L/700 L water– 38 L/1,900 L water	Monitor scaffold branches and apply when crawlers are active. Some of these products are toxic to bees. Do not apply when bees are active on flowering weeds or other crops in the treatment area. Refer to label for specific bee toxicity statements. Closer: For control of San Jose scale. Movento: Use postbloom only. Control of San Jose scale, and suppression of Lecanium scale. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Mites	• Kanemite 15 SC (20) • Envirodor 240 SC (23) • Acramite 50 WS (UN) • Opal (NC)	2.07 L/ha 750 mL/ha 568 g/ha 14 L/700 L water– 38 L/1,900 L water	Apply when mites are active on foliage. Kanemite: Maximum of 1 application per season. Envirodor: Use postbloom only. Acramite: Rate controls two-spotted spider mite. If European red mite is present, apply 851 g/ha. Maximum of 1 application per season. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Leafhopper	• Admire 240 F (4)	200 mL/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Use postbloom only.
Butternut curculio	• Delegate WG (5) • Surround WP (NC)	420 g/ha 50 kg/ha	Delegate: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Apply at first sign of feeding damage after bloom. Re-apply 14 days later depending on pest pressure. Surround: Apply when visual inspection shows adult feeding and egg-laying scars in new flower shoots. See <i>Using Organic and Biopesticide Products</i>, page 242.
Husk maggot	• GF-120 Fruit Fly Bait (5) • Delegate WG (5) • Surround WP (NC)	1.5 L/6 L water 420 g/ha 50 kg/ha	GF-120: Under high pest pressure, this product may provide suppression only. Apply when first fly is caught on sticky traps. Re-apply weekly while flies are present. See <i>Using Organic and Biopesticide Products</i>, page 242. Delegate: Apply 7–10 days after first fly is caught on sticky traps. Re-apply 14 days later depending on pest pressure. Surround: Apply when sticky traps show adult activity, typically August to mid-September. See <i>Using Organic and Biopesticide Products</i>, page 242.
Walnut blight	Use one of the products listed for walnut blight at Prebloom . See Table 7-1. <i>Products Used on Tree Nuts</i> , page 228 for preharvest intervals. Last copper spray should be no later than husk split.		
Botrytis grey mould	• Fontelis (7)	1.0–1.5 L/ha	Botrytis is not a common problem on tree nuts. Apply only if there has been a history of disease. Begin application prior to disease development and repeat in 7–14 days if needed. Will also provide control of brown rot (<i>Monilinia</i> spp.) and suppression of <i>Alternaria</i> leaf spot.

Pecan and Sweet Chestnut Calendar

Read the label and follow all safety precautions.

For preharvest interval, re-entry period, and maximum number of applications, see Table 7-1. *Products Used on Tree Nuts*, page 228.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (leafrollers), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Spray Water Volumes

Thorough coverage of all affected plant surfaces is essential for maximum efficacy of many tree nut products. Sufficient water volumes are necessary to provide complete coverage with insecticides, miticides and fungicides. Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, or if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to tree nuts during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Prebloom			
Leafrollers	• Delegate WG (5)	210–420 g/ha	Apply when larvae have emerged and before they roll up in the leaves. Re-apply in 1–2 weeks, if needed. Dipel: Use 1.6 kg/ha for large or mature trees. See <i>Using Organic and Biopesticide Products</i> , page 242. Exirel: Do not tank-mix or make sequential applications with copper products.
	• Dipel 2X DF (11)	1.12 kg/ha	
	• Intrepid 240 F (18)	750 mL/ha	
	• Altacor (28)	145–285 g/ha	
	• Exirel (28)	0.5–1.0 L/ha	
Aphids	• Closer SC (4)	100–200 mL/ha	Begin monitoring in mid-spring for young nymphs. Aphids on chestnut and pecan are generally controlled by natural predation. For best results, apply in early stages of aphid infestation. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	

Disease or Insect	Product (Group)	Rate	Comments
Leafhoppers	• Surround WP (NC)	50 kg/ha	Leafhoppers are primarily a problem on younger, newly establishing orchards. Surround: Reduction in damage only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Use on sweet chestnut only. Begin applications at initial infestation, as determined by monitoring. Repeat at 7–14-day intervals as needed. See <i>Using Organic and Biopesticide Products</i> , page 242.
Scale	• Closer SC (4) • Opal (NC)	200–400 mL/ha 14 L/700 L water– 38 L/1,900 L water	Scale is rarely a problem in chestnuts or pecans. Monitor scaffold branches and apply when crawlers are active. Closer: For control of San Jose scale. Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Mites	• Kanemite 15 SC (20) • Acramite 50 WS (UN) • Opal (NC)	2.07 L/ha 568 g/ha 14 L/700 L water– 38 L/1,900 L water	Apply when mites are active on foliage. Kanemite: Maximum of 1 application per season. Acramite: Rate controls two-spotted spider mite. If European red mite is present, apply 851 g/ha. Maximum of 1 application per season. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Dogwood borer	• Isomate DWB	250–375 dispensers/ha	Dogwood borer is not commonly a pest of tree nuts. Apply where there is a history of infestation. Reduces mating of dogwood borer. Apply before adult borer emergence (end of May). Use high rate for high-pressure areas or initial year of treatment. See <i>Mating Disruption in Fruit Crops</i> , page 250.

First pistillate flower

**INSECTICIDES MAY BE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING.
SPRAY IN THE EVENING. SEE BEE POISONING, PAGE 269.**

Butternut curculio	• Delegate WG (5) • Surround WP (NC)	420 g/ha 50 kg/ha	Delegate: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Apply at first sign of feeding damage after bloom. Re-apply 14 days later depending on pest pressure. Toxic to bees. Do not apply when bees are active on flowering weeds or other crops in the treatment area. Surround: Use on pecan only. Apply when visual inspection shows adult feeding and egg-laying scars on new flower shoots. See <i>Using Organic and Biopesticide Products</i> , page 242.
Aphids	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Leafhoppers	Use one of the products listed for leafhoppers at Prebloom .		
Scale	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.

Summer sprays

Leafroller	• Delegate WG (5) • Dipel 2X DF (17) • Intrepid 240 F (18) • Altacor (28) • Exirel (28)	210–420 g/ha 1.12 kg/ha 750 mL/ha 145–285 g/ha 0.5–1.0 L/ha	Degree-day models for apples may help with timing. Delegate: Apply at first egg hatch. Dipel: Apply when small larvae are present. Use 1.6 kg/ha for large or mature trees. See <i>Using Organic and Biopesticide Products</i> , page 242. Intrepid: Apply at first egg hatch. Re-apply 10–14 days later if needed. Altacor, Exirel: Apply at first egg hatch. Re-apply 10 days later if needed. Do not tank-mix or make sequential applications of Exirel with copper products.
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Disease or Insect	Product (Group)	Rate	Comments
Aphids	• Admire 240 F (4)	230 mL/ha	For best results, apply in early stages of aphid infestation. Admire, Movento: Use postbloom only. Admire, Closer: Maximum of 2 applications per season. Movento: Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Closer SC (4)	100–200 mL/ha	
	• Movento 240 SC (23)	365 mL/ha	
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Scale	• Closer SC (4)	200–400 mL/ha	Monitor scaffold branches and apply when crawlers are active. Closer: For control of San Jose scale. Movento: Use postbloom only. For control of San Jose scale, and suppression of Lecanium scale. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Movento 240 SC (23)	585 mL/ha	
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Mites	• Kanemite 15 SC (20)	2.07 L/ha	Apply when mites are active on foliage. Kanemite: Maximum of 1 application per season. Envidor: Use postbloom only. Acramite: Rate controls two-spotted spider mite. If European red mite is present, apply 851 g/ha. Maximum of 1 application per season. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
	• Envidor 240 SC (23)	750 mL/ha	
	• Acramite 50 WS (UN)	568 g/ha	
	• Opal (NC)	14 L/700 L water– 38 L/1,900 L water	
Leafhoppers	• Admire 240 F (4)	200 mL/ha	Leafhoppers are primarily a problem on younger, newly establishing orchards. Admire: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Surround: Reduction in damage only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Use on sweet chestnut only. Begin applications at initial infestation, as determined by monitoring. Repeat at 7–14-day intervals as needed. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Surround WP (NC)	50 kg/ha	
Butternut curculio	• Delegate WG (5)	420 g/ha	Delegate: Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i>, page 267. Apply at first sign of feeding damage after bloom. Re-apply 14 days later depending on pest pressure. Surround: Use on pecan only. Apply when visual inspection shows adult feeding and egg-laying scars on new flower shoots. See <i>Using Organic and Biopesticide Products</i>, page 242.
	• Surround WP (NC)	50 kg/ha	
Botrytis grey mould	• Fontelis (7)	1.0–1.5 L/ha	Botrytis is not a common problem on tree nuts. Apply only if there has been a history of disease. Begin application prior to disease development and repeat in 7–14 days if needed. Will also provide control of brown rot (<i>Monilinia</i> spp.) and suppression of Alternaria leaf spot.

Filbert/Hazelnut Calendar

Read the label and follow all safety precautions.

For preharvest interval, re-entry period, and maximum number of applications, see Table 7-1. *Products Used on Tree Nuts*, page 228.

Resistance Management

To delay development of resistance to insecticides, miticides and fungicides, follow resistance management guidelines outlined in *Resistance Management Strategies*, page 257. The chemical group is indicated in brackets following the product name. Products belonging to the same chemical group are grouped together in the calendar. Multi-site (*M*) fungicides are not prone to resistance and do not have to be rotated. Some products are not classified to mode of action (*NC*) and the mode of action has not been determined for others (*U* or *UN*).

Fungicide resistance management

Take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use products containing the same chemical group in consecutive applications.

Insecticide resistance management

Take the following steps to avoid development of insecticide resistance:

- For pests with discrete generations (leafrollers), do not use insecticides from the same group for more than one generation. Within a generation, if more than one spray is required, use a product from the same chemical group.
- For pests with overlapping generations (aphids, mites), do not use products containing the same chemical group in consecutive applications.

Spray Water Volumes

Thorough coverage of all affected plant surfaces is essential for maximum efficacy of many tree nut products. Sufficient water volumes are necessary to provide complete coverage with insecticides, miticides and fungicides. Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, or if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Bee Toxicity

Some insecticides are toxic to bees and other pollinating insects. Use of insecticides on flowering crops requires careful management to avoid negative effects on pollinators. Some insecticides cannot be applied prior to or during bloom. For others, use extreme caution when applying insecticides to tree nuts during bloom – do not apply them while bees are active in the orchard. Before and after bloom, bees may still be present on flowering cover crops and weeds – do not allow drift of insecticides onto these or other flowering crops. Always follow label precautions regarding avoiding impacts on bees. For more information, see *Bee Poisoning*, page 269.

Disease or Insect	Product (Group)	Rate	Comments
Bud break (up to ¼-inch vegetative growth)			
Eastern filbert blight	• Guardsman Copper		Apply all products preventatively.
	• Oxychloride 50 (<i>M</i>)	3–9 kg/ha	Copper: Apply from bud swell to bud break, when tissue is susceptible to infection. Use 3 kg/ha on small trees and up to 9 kg/ha on large trees.
	• or Copper Spray (<i>M</i>)	3–9 kg/ha	
	• Bravo 500 (<i>M</i>)	6.72 L/ha	Bravo: Apply from bud break to shoot elongation. Do not tank-mix or apply within 1 week of oil.
	• Flint (<i>11</i>)	140–280 g/ha	Flint: Apply at bud break and continue as needed on a 14-day interval. Use 140 g/ha on small trees or up to 280 g/ha on larger trees. Avoid drift, especially onto Concord grapes.

Disease or Insect	Product (Group)	Rate	Comments
Early spring (> ¼-inch vegetative growth)			
INSECTICIDES MAY BE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE BEE POISONING, PAGE 269.			
Eastern filbert blight	Use one of the products listed for Eastern filbert blight at Bud break . Some products have limited numbers of applications per year. See Table 7-1. <i>Products Used on Tree Nuts</i> , page 228.		
Leafrollers	• Delegate WG (5) • Dipel 2X DF (11) • Intrepid 240 F (18) • Altacor (28) • Exirel (28) • Surround WP (NC)	210–420 g/ha 1.12 kg/ha 750 mL/ha 145–285 g/ha 0.5–1.0 L/ha 50 kg/ha	Apply when larvae have emerged and before they roll up in the leaves. Re-apply in 1–2 weeks, if needed. Dipel: Use 1.6 kg/ha for large or mature trees. See <i>Using Organic and Biopesticide Products</i> , page 242. Exirel: Do not tank-mix or make sequential applications with strobilurin or copper fungicides. Surround: Reduction in damage only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Make a second application 10 days later. Repeat at 7–14-day intervals as subsequent generations emerge. See <i>Using Organic and Biopesticide Products</i> , page 242.
Aphids	• Lagon 480 E (1) • Cygon 480-AG (1) • Warhawk 480 EC (1) • Admire 240 F (4) • Closer SC (4) • Movento 240 SC (23) • Opal (NC)	5 L/ha 5 L/ha 4.2–4.8 L/ha 230 mL/ha 100–200 mL/ha 365 mL/ha 14 L/700 L water– 38 L/1,900 L water	For best results, apply in early stages of aphid infestation. Lagon, Cygon: Apply primarily on younger trees when aphids appear. Warhawk: Filbert aphid only. Use in 100 L/ha. This product is highly toxic to beneficial insects and may lead to mite outbreaks. Maximum of 1 application per season. Admire, Movento: Use postbloom only. Movento: Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Mites	• Kanemite 15 SC (20) • Envidor 240 SC (23) • Acramite 50 WS (UN) • Opal (NC)	2.07 L/ha 750 mL/ha 568 g/ha 14 L/700 L water– 38 L/1,900 L water	Mites on hazelnuts are usually controlled by natural predators. Treat in late spring or early summer if populations become high and leaf bronzing appears. Kanemite: Maximum of 1 application per season. Envidor: Use postbloom only. Acramite: Rate controls two-spotted spider mite. If European red mite is present, apply 851 g/ha. Maximum of 1 application per season. Opal: Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Scale	• Closer SC (4) • Movento 240 SC (23) • Opal (NC)	200–400 mL/ha 585 mL/ha 14 L/700 L water– 38 L/1,900 L water	Monitor scaffold branches for adult scale. Spray when crawlers are active. Closer: For control of San Jose scale. Movento: Use postbloom only. For control of San Jose scale and suppression of Lecanium scale. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Control may not be apparent for 2–3 weeks. Under high pest pressure, re-apply 2 weeks later. Tank-mix with an adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details. Do not tank-mix with sulphur. Opal: For control of soft brown scale. Re-apply every 1–3 weeks as needed. Maximum of 3 applications per season. Avoid application in direct sunlight.
Leafhopper	• Admire 240 F (4)	200 mL/ha	Suppression only. See Table 11-1. <i>Pesticide Efficacy Ratings</i> , page 267. Toxic to bees. Apply only after bloom and do not apply to flowering weeds and cover crops if bees are active in the treatment area.
Dogwood borer	• Isomate DWB	250–375 dispensers/ha	Dogwood borer is not commonly a pest of tree nuts. Apply where there is a history of infestation. Reduces mating of dogwood borer. Apply before adult borer emergence (end of May). Use high rate for high-pressure areas or initial year of treatment. See <i>Mating Disruption in Fruit Crops</i> , page 250.

Disease or Insect	Product (Group)	Rate	Comments
Summer			
Aphids	Use one of the products listed for aphids at Early spring (> ¼-inch vegetative growth).		
Leafhopper	Use one of the products listed for leafhoppers at Early spring (> ¼-inch vegetative growth).		
Mites	Use one of the products listed for mites at Early spring (> ¼-inch vegetative growth).		
Botrytis grey mould	• Fontelis (7)	1.0–1.5 L/ha	Botrytis is not a common problem on tree nuts. Apply only if there has been a history of disease. Begin application prior to disease development and repeat in 7–14 days if needed. Will also provide control of brown rot (<i>Monilinia</i> spp.) and suppression of <i>Alternaria</i> leaf spot.
Postharvest			
Bacterial blight	• Guardsman Copper Oxychloride 50 (M) or Copper Spray (M)	3–9 kg/ha 3–9 kg/ha	Apply the first spray in late August or early September before the start of the fall rains and nut drop. Repeat after harvest at leaf fall and in early spring just before leaf bud break. Use 3 kg/ha on small trees, and up to 9 kg/ha on large trees in proportionately more water.

Table 7-1. Products Used on Tree Nuts

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)	Registered nut crops ¹
Products for insect control or suppression							
Acramite 50 WS	27925	bifenazate	UN	14 days	12 hours	1	W, P, C, H
Admire 240 F	24094	imidacloprid	4A	7 days	24 hours	2	W, P, C, H
Altacor	28981	chlorantraniliprole	28	10 days	12 hours	3 (max. 645 g/ha)	W, P, C, H
Closer SC	30826	sulfoxaflor	4C	7 days	12 hours	2	W, P, C, H
Cygon 480-AG	25651	dimethoate	1B	45 days	12 hours	1	H
Delegate WG	28778	spinetoram	5	14 days	12 hours	3	W, P, C, H
Dipel 2X DF	26508	<i>Bacillus thuringiensis</i>	11	0 days	12 hours	—	W, P, C, H
Entrust 80 W	27825	spinosad	5	14 days	when dry	3	W
Envirdor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1	W, P, C, H
Exirel	30895	cyantraniliprole	28	5 days	12 hours	4	W, P, C, H
GF-120 Fruit Fly Bait	28336	spinosad bait	5	0 days	when dry	10	W
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	max. 2 L/ha	W, P, C, H
Kanemite 15 SC	28641	acequinocyl	20B	14 days	12 hours	2	W, P, C, H
Lagon 480 E	9382	dimethoate	1B	45 days	12 hours	1	H
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max 1.58 L/ha	W, P, C, H

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ Indicates which nut crops product is registered on. W = walnut, P = pecan, C = chestnut, H = hazelnut.

² Apply Opal to a maximum of 3 consecutive applications to ensure plant injury does not occur. Additional applications may be possible if previous experience with repeat applications of the product under the same conditions have not produced plant injury.

³ General re-entry.

⁴ Scouting activities.

⁵ Orchard maintenance.

⁶ Transplanting.

⁷ Preharvest interval is 1 day for hazelnut or 40 days for walnut.

⁸ Maximum 3 applications per year for hazelnut or 4 applications per year for walnut.

Table 7-1. Products Used on Tree Nuts (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)	Registered nut crops ¹
Opal	28146	potassium salts of fatty acids	NC	0 days	12 hours	3 ²	W, P, C, H
Surround WP	27469	kaolin	NC	1 day	12 hours	—	W, P, C, H
Warhawk 480 EC	29984	chlorpyrifos	1B	14 days	48 hours ³ / 4 days ⁴	3	H
Products for disease control or suppression							
Bravo 500	15723	chlorothalonil	M	120 days	48 hours ⁵ / 72 hours ⁵ / 11 days ⁶ / 20 days ⁴	3	H
Copper Spray	19146	copper oxychloride	M	1 day/ 40 days ⁷	48 hours	3/4 ⁸	W, H
Flint	30619	trifloxystrobin	11	60 days	12 hours	4	H
Fontelis	30331	penthiopyrad	7	14 days	12 hours	max. 4.5 L/ha	W, P, C, H
Guardman Copper Oxychloride 50	13245	copper oxychloride	M	1 day	48 hours	3	H
Kasumin 2L	30591	kasugamycin	24	100 days	12 hours	4	W

M = Multi-site fungicides. NC = Not classified by FRAC/IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

— = Information is not specified on the product label.

¹ Indicates which nut crops product is registered on. W = walnut, P = pecan, C = chestnut, H = hazelnut.

² Apply Opal to a maximum of 3 consecutive applications to ensure plant injury does not occur. Additional applications may be possible if previous experience with repeat applications of the product under the same conditions have not produced plant injury.

³ General re-entry.

⁴ Scouting activities.

⁵ Orchard maintenance.

⁶ Transplanting.

⁷ Preharvest interval is 1 day for hazelnut or 40 days for walnut.

⁸ Maximum 3 applications per year for hazelnut or 4 applications per year for walnut.

TREE NUTS

8. Other Pests and Disorders

Nematodes

There are many beneficial nematodes in agricultural soil, but when plant parasitic nematodes are present in high numbers, they can cause significant yield losses to horticultural crops. The extent of loss depends on the crop, nematode species and soil populations.

The most destructive and common nematodes in Ontario fruit crops are root-lesion (*Pratylenchus penetrans*) and northern root-knot (*Meloidogyne hapla*). The northern root-knot nematode is becoming more prevalent. The pin (*Paratylenchus* sp.) and dagger (*Xiphinema* sp.) nematodes occasionally cause yield losses to some fruit crops in isolated fields. The dagger nematode is mainly a virus vector on grape, raspberry and apple.

Generally, symptoms of nematode injury include:

- uneven plant growth
- poor plant establishment
- plants weakening over time
- poor root growth
- knots or galls on roots
- excessive branching of roots, hairy root symptoms

On strawberries:

- Root-lesion nematodes cause discolouration of the fine feeder roots and tiny brown scratch-like lesions on the young white roots. These lesions merge to form large brown areas. Root-lesion nematodes are involved in black root rot and aggravate verticillium wilt of strawberries and other host plants. Severely infected plants appear stunted and unthrifty.
- Root-knot nematode feeding stimulates root cells to enlarge. Enlarged cells look like small galls or beads (1 mm). As more and more nematodes establish feeding sites, they join together to become one larger root-knot.

On raspberries:

- Root-lesion nematode feeding causes scratch-like lesions on roots, similar to the symptoms on strawberry roots. Severely infested plants have thinner and fewer canes per crown. Up to 25% of first-year canes may be killed by severe infestations of these nematodes.

- Dagger nematodes spread tomato ringspot virus, which causes crumbly berries, mottled leaves and cane dieback.

On tree fruits:

- Root-lesion nematodes can be a major cause of orchard replant failures, and are a significant factor in Apple Replant Disorder (ARD). They can cause a decline in vigour of existing peach and cherry orchards. These nematodes cause small brown lesions on the white lateral roots and kill the fine feeder roots. When lesions merge, the entire root system appears discoloured. Root lesions are frequently invaded by other pathogens which can cause root rot. Severely affected trees may lose all feeder roots; young replant trees may die. Existing trees lack uniformity.

Thresholds

Nematode populations above economic thresholds can significantly reduce yields. The economic threshold for nematode populations refers to the population at planting. Planting a susceptible crop in soils with a population of nematodes near or above the population threshold will result in crop losses over time. For economic thresholds see Table 8-1. *Nematode Thresholds for Fruit Crops* on this page.

Table 8-1. Nematode Thresholds for Fruit Crops

Type of Nematode	Economic Threshold (nematodes/kg soil)
Root-lesion	1,000 (exception: 500 on strawberries)
Root-knot	1,000
Pin	5,000
Dagger	100
Bulb and stem	100

- Nematode problems are most often found in sandy-loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops.
- Root-lesion and root-knot nematode problems are not usually found in clay or clay-loam soils. Sample these soils for nematodes before planting in replant sites or where susceptible crops have been recently grown.

- Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grape, raspberry or tree fruit.

For more information, see OMAF Factsheet, *Sampling Soil and Roots for Plant Parasitic Nematodes*. Information on how to sample soil for nematodes and where to send the samples is found in Appendix G: *Diagnostic Services*, page 299.

Nematode management

Nematode management starts in the year before planting. Try to reduce nematode populations so that clean stock can establish well before the nematodes rebound to damaging levels. Young plants tolerate much less nematode feeding than established plants. Use a combination of the following methods to manage nematodes:

- Order only nematode-free transplants and seedlings.
- Rotate susceptible crops with non-host crops for several years.
- Plant nematode-suppressing cover crops in the preplant years.
- Destroy residual crop roots.
- Plant resistant fruit cultivars where available.
- Control weeds, as they are good hosts of nematodes.
- Use soil fumigation when necessary, as indicated by soil analysis.

Cover crops for nematode suppression

Cover crops may reduce populations of nematodes when properly managed in the year before planting. In Ontario, these nematode-suppressing cover crops have been successful:

- oilseed radish
- certain oriental mustard cultivars like Caliente, Cutlass or Forge
- specific sorghum × sudan-grass hybrids
- African marigold cultivars like Crackerjack or Creole and
- Canadian Forage Pearl Millet 101

These cover crops can reduce plant parasitic nematode populations. Not all cultivars reduce nematode populations, so choose the right variety. One or more years of nematode-suppressing cover crops may be required to reduce nematodes below economic thresholds.

Cover crops suppress nematodes in different ways:

- Canadian Forage Pearl Millet 101 is a poor host and inhibits the ability of root lesion nematodes to reproduce in its root-system.
- Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil.
- Nematode-suppressing cultivars of oilseed radish and certain oriental mustards produce glucosinolates and an enzyme in their leaves, stems and petioles. The enzyme converts the glucosinolates into isothiocyanates, which are toxic to nematodes when the cover crop is cut green and incorporated immediately into the soil.

Exclude cover crops such as clovers and buckwheat from berry and orchard rotations. These are excellent hosts for root-lesion nematodes. Wheat or barley are the best cereal crops to grow before planting. For more information, see Table 2-17. *Characteristics of Cover Crops*, page 25.

Other cultural practices to reduce nematodes

Nematode populations can build on many weed species. A good weed control program is essential the year before planting fruit crops. Plan an intensive weed management strategy for the cover crop where nematode-suppressing cover crops are grown.

Keep land fallow the year before planting to reduce nematode numbers. A disadvantage to fallow land is increased susceptibility to soil erosion.

In orchards, choose ground covers for planting between the rows that do not support nematodes, such as annual or perennial ryegrass, or creeping red fescue.

Soil fumigation

Pre-plant soil fumigation is the most effective method of controlling nematode problems. Fumigants can be broadcast over the whole field or applied only in bands where trees will be planted. Tree-row application, or the treatment of a 2–2.5 m strip centred on the row, is more economical, but requires good planning. However, broadcast fumigation will reduce the risk of re-contamination if non-fumigated soil is mixed into the fumigated strip.

For products, rates and other information on fumigants, refer to Table 8-2. *Products for Management of Nematodes and Other Soil-borne Pests*, page 233.

Application of fumigants before planting

Most fumigants are applied by shank injection using specialized application equipment. Some formulations of metam sodium can be applied to the soil surface and watered in. See the product label for application instructions.

- Fumigate when soil temperatures are above 4°C at 20 cm depth. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil. Fumigation in the early fall before planting is best for fruit crops which are planted in early spring when soils are still cool.
- Land preparation is critical for effective fumigant application. Remove trash and old root systems. One week prior to fumigation, work the soil to a depth of 25–30 cm and obtain good seedbed tilth and moisture. Keep soil moist and if necessary irrigate the treated area during the week prior to fumigation.
- Seal the soil surface by packing or watering immediately after injection of the fumigant. For best results, keep the soil surface moist during application and for 24 hours after application.
- Leave soil undisturbed for at least 1 week after injection of the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
- Work the soil and aerate for about a week before planting. For fall planting, work the soil and aerate for 2 weeks before planting. The time interval between fumigation and planting into fumigated soil depends upon the product used, the rate and the temperature following fumigation (consult product label).
- Use high-quality planting stock, preferably grown in fumigated soil. Nursery operators can provide information on how to manage nematodes.
- Always read the product label.

Table 8-2. Products for Management of Nematodes and Other Soil-borne Pests

CAUTION: These products are very toxic. Read the label and follow instructions for handling and application. Always follow manufacturer's directions carefully for dosage and methods of use. The applicator must wear suitable protective clothing, etc. These requirements vary between products and can be found on the label.

Product	Active Ingredient	Ontario Class ¹	Pests Controlled ²			Fruit Crop Registrations	Rates (shank injection or surface applied)	Rates (sprinkler application)
			Nematodes	Soil-borne Diseases	Weeds			
Busan 1020	metam sodium 33%	4	yes	yes	yes	fruit crops	375–935 L/ha (shank injection)	700–935 L/ha
Busan 1180	metam potassium 54%	3	yes	yes	yes	fruit crops	231–576 L/ha (shank injection)	431–576 L/ha
Busan 1236	metam sodium 42%	4	yes	yes	yes	fruit crops	274–683 L/ha (shank injection)	511–683 L/ha
Chloropicrin 100	chloropicrin 99%	2	yes	yes	no	strawberries, raspberries	93 L/ha ³ (shank injection)	do not apply with sprinklers
Enfuse M 510	metam sodium 42%	4	yes	yes	yes	fruit crops	260 L/ha (surface applied)	do not apply with sprinklers
Pic Plus	chloropicrin 85.1%	2	yes ⁴	yes	no	strawberries, raspberries	108 L/ha ⁵ (shank injection)	do not apply with sprinklers
MustGrow	oriental mustard seed meal 100%	3	yes ⁶	yes ⁶	no	strawberries, raspberries	980–2,240 kg/ha (surface applied)	do not apply with sprinklers
Vapam HL	metam sodium 42%	4	yes	yes	yes	fruit crops	279–696 L/ha (shank injection)	350–670 L/ha

¹ See Table 11-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4*, page 286.

² See label for exact registrations.

³ Use 140 L/ha Chloropicrin 100 for strawberry plant production (runner production).

⁴ Pic Plus is labelled for root knot nematode but is not labelled for root lesion nematode.

⁵ Use 162 L/ha PicPlus for strawberry plant production (runner production).

⁶ MustGrow provides suppression rather than control of nematodes and soil-borne diseases. For more information on MustGrow, see *Organic and Biopesticide Products*, page 241.

Fumigating single-tree sites before planting replacement trees

When trees are replanted within an existing orchard, nematodes and diseases can be controlled in the planting hole using Vapam or Busan before planting. Refer to the product label for application details, rates and safety precautions.

Re-evaluation of soil fumigants

Soil fumigants are under re-evaluation by the Canadian Pest Management Regulatory Agency (PMRA).

New requirements for soil fumigant applications are expected to be implemented in 2014. At this time, the PMRA is requiring label improvements to further limit user exposure, and to protect bystanders and the environment. The re-evaluations are ongoing, so growers should refer to current product labels for updated requirements.

- Before applying soil fumigants, a Soil Fumigation Management Plan must be developed and implemented. See label for details.
- Entry into the fumigation application block by any person — other than personal protective equipment (PPE)-equipped handlers, emergency personnel, and local, provincial, or federal officials performing inspection, sampling, or other similar official duties — is PROHIBITED during the Entry Restricted Period.
- For all non-tarped applications, the Entry Restricted Period begins at the start of application and expires 5 days after the application is complete.
- The applicator must verbally warn workers of the application.
- Fumigant application signs must be posted on all entrances to the application block. Signs must be posted prior to the start of the application (but no sooner than 24 hours prior to application) and remain posted for the duration of the Entry Restricted Period. Signs must be removed within 3 days after the end of the Entry Restricted Period.
- A buffer zone must be established for every fumigant application.

Restrictions on application conditions for soil fumigants include the following:

- DO NOT apply if an air stagnation advisory is in effect or is forecast for the area in which the application is planned, either during the application or until 48 hours after the application is complete.
- DO NOT apply if light wind conditions (<3 km/hr) are forecast to persist for more than 18 consecutive hours from the time the application starts until 48 hours after the application is complete.

Nematode suppression after planting

Vydate L will suppress nematodes after planting non-bearing apples (trees that will not bear fruit for 12 months) and raspberries. Vydate L is less effective than pre-plant soil fumigation and does not control soil-borne disease. Refer to the product label for application methods, mixing instructions, rates and precautions.

Apples

- **Soil drench and foliar spray:** Treat young whips and non-bearing fruit trees with 1 application of Vydate L as a soil drench around the base of each tree when roots are actively growing and leaf growth begins in the spring. Follow this with a foliar application of Vydate L; or,
- **Foliar application:** Make 3 foliar applications on 2–3-week schedule for a total of 3 applications. Do not allow spray to drift onto trees in bloom. Do not apply to trees under water stress or not actively growing.

Raspberries

- Treat raspberry plants with 1 application of Vydate L as a soil drench over roots in the fall before October 31. Do not apply Vydate L to raspberries in the spring. Do not apply to raspberries more than once a year.

Vydate L is highly toxic to bees. Do not apply during the pink or bloom period.

Vydate L is very toxic to humans. Follow application instructions closely.

Do not re-enter treated fields for 48 hours after application.

Deer Management

Deer are attracted to fruit crops, especially apples and strawberries, and browse at different times during the season. They can cause extensive damage, particularly in fields located near large populations. Controlling deer damage requires an integrated approach, which includes regulated hunting (with permit), scare devices, repellents and fencing (conventional or electric). Where pressure is heavy, a high tensile wire fence may be the only solution.

Deer removal permit program

A permit is required to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of problem deer control. The MNR area supervisor or enforcement supervisor issues permits to farmers or their agents. Take these steps to request a permit:

- File a written report, reflecting the extent of damage in percentage of crop loss and associated dollar value. The evaluator must consider the damage to be economically significant.
- Demonstrate that you have made reasonable attempts to control deer by modified farm management practices. Show that you permit licensed deer hunters on the property during open season, if any. Document this information and keep it with the deer removal permit file.
- Ensure appropriate arrangements for the disposal of the carcass(es).

For more information, see OMAF Factsheet, *Rodent and Deer Control in Orchards*.

Mouse and Vole Management

Mice and voles can cause widespread damage in orchards that provide attractive shelter, especially in new plantings.

- Use a wide weed-free strip in the tree row or under individual trees, coupled with regular close mowing of orchard ground cover to help discourage mice.
- Remove straw, trash, sod, etc. from around the base of the tree for at least 60 cm from the trunk.

- Encourage predation by cats, foxes and birds of prey, especially red-tailed hawks, kestrels and great horned owls, which all help to reduce mouse populations.

Use a guard around the trunk of all newly planted trees. A number of commercial tree guards are available. Two of the most common are spiral plastic and galvanized wire mesh. Bury the bottom of the guard in the soil 5 cm deep, or preferably, in a mound of fine crushed stone or sharp cinders. Tree guards should be removed and inspected regularly.

- Check tree guards each fall to ensure they are mouse-proof and free of trash.
- Ensure tree guards do not interfere with root development as the tree grows.
- Spiral guards left in place too long can interfere with bark development. Remove guards before this occurs.

Bait for mouse and vole management

Removing dropped fruit from the orchard may help to reduce rodent populations. However, in orchards with high mice and vole pressure, the use of baits may be necessary to reduce populations.

Bait stations help control mice longer than broadcast treatment. Bait stations also help prevent non-target mammals from feeding on the bait. Set up bait stations at a rate of approximately 25 stations/ha, in locations not accessible to children, pets or livestock.

To ensure safe use of this product, tamper-resistant bait stations must have the following characteristics:

- constructed of high-strength materials and resistant to destruction by children and non-target animals
- entrance designed to ensure children and non-target animals cannot reach the bait
- internal structure that prevents bait from being shaken loose
- access panel that fastens securely and locks (e.g., metal screw or padlock)
- capable of being securely fastened to a surface (e.g., nailed down)
- clearly labelled: WARNING – POISON

Table 8-3. Bait for Mouse and Vole Management

Product Name	Active Ingredient	Application Rates	Crop Registrations	Comments
Ramik Brown	diphacinone	• no application rates on the label	orchards, Christmas tree plantations, newly reforested areas, shelter belts and nurseries	Bait MUST be placed in either tamper-resistant bait stations or in locations not accessible to children, pets or livestock. DO NOT place bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food.
Bartlett Waxed Mouse Bait	zinc phosphide	• 4.5–9 kg/ha, depending on severity of infestation OR • place in bait stations, 15 g of bait per bait station	orchards, Christmas tree plantations, newly reforested areas, etc.	Apply in early fall, or any time before a covering of snow. Distribute evenly but do not apply to bare ground.
Rodent Bait or Pellets	zinc phosphide	• 4.5–9 kg/ha, depending on severity of infestation OR • place in bait stations	orchards, nurseries, fruit and vegetable storage areas (in bait stations)	Best timing is after harvest before leaf-fall or lodging of the grass. Repeat at least once before snow is expected.

Broadcast bait should be applied over the floor of the orchard before the grass falls and the ground is covered with snow. Apply bait on bright days with no rain expected for several days. If further mouse activity is detected, repeat the treatment when rain is not expected.

See Table 8-3. *Bait for Mouse and Vole Management*, on this page, for several commercial bait formulations that are available for orchard use. Consult the label before application and obey all safety instructions.

- Baits are poisonous to humans, domestic animals and wildlife.
- Store the bait away from children, irresponsible persons and animals.
- Wear chemical-resistant gloves and wash hands after handling poison baits.
- Avoid inhalation of dust or fumes.
- Destroy empty containers safely.
- Keep children, pets and domestic animals away from treated areas.
- Where possible, remove mouse bodies and bury or dispose of them in a safe manner.

For more information, see OMAF Factsheet, *Rodent and Deer Control in Orchards*.

Rabbit Management

Wrapping young trees

To protect young trees from rabbits, wrap burlap around the top and the trunk of the tree (above the mouse guard). Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

Repellents

Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. Products such as Skoot, and other commercial mixtures containing thiram, can be painted directly onto the tree trunks by hand or diluted with water for backpack sprayer application. Be sure to treat the tree as high as rabbits can reach when they stand on deep snow.

For more information about the application of paint with thiram, refer to *Control of Southwest Injury on Fruit Trees*, page 238.

Repairing damage by mice and rabbits

Carry out regular inspection throughout the winter to check for injury. Mice often feed just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, cover the wound with grafting compound or wound dressing promptly or before it dries out.

The process for repairing fruit trees damaged by mice and rabbits is described in OMAF Factsheet, *Repair Grafting*. Before the buds swell in the early spring, secure scions that are long enough to bridge the wound.

Store scions in damp sand or sawdust in a cool place, preferably in refrigerated conditions. Avoid storing scions with apple fruit to avoid ethylene damage. If the wound extends for more than one quarter of the circumference of the trunk, use scions to connect the healthy tissue by bridge grafting. Graft when the bark slips readily from the wood, usually about bloom. This technique is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

For more information, see OMAF Factsheet, *Rodent and Deer Control in Orchards*.

Bird Management

Every year birds destroy large quantities of fruit in Ontario. Sweet cherries, grapes, blueberries and saskatoon berries are the crops most subject to attack, but other fruit crops may also be damaged. The amount of loss due to birds depends on the cultivar, the time of season, location in the province, proximity to bush and hydro lines, and availability of other food sources. Losses range from relatively minor to total crop loss. Actual losses are difficult to measure, since fruit that has disappeared is hard to account for. Pecking and puncturing damage are often as great as actual losses from fruit consumed and can cause secondary problems with rot.

Managing bird damage

Fruit becomes attractive to birds as it begins to colour. Birds are very selective and quickly learn where to find the most tasty, ripe fruit. Start controls early, 10–30 days prior to colouring of the fruit, depending upon the cultivar. An integrated approach using several control methods is necessary for effective and long-lasting control.

Regardless of the bird control method used, follow all local, provincial and federal laws. For more information on bird control, see OMAF Factsheet, *Bird Control on Grape and Tender Fruit Farms*.

Location

Where you plant commercial fruit crops can be an important factor in bird control. Fruit crops planted near wooded areas or hydro lines are particularly susceptible to damage, because birds nearby find shelter, perching locations and nest sites.

Physical protection

The only completely effective control method is to cover the crops with netting. This method may be economically feasible for some higher valued cultivars of grapes, cherries and highbush blueberries. However, nets are not the answer in every situation since they can be costly to purchase and install, as well as difficult to work with. There is considerable interest by growers to find simpler, cost-effective netting systems for fruit crops.

Shooting

Normally, shooting does not significantly reduce bird populations, but it does frighten them out of the orchard. Laws protect robins and northern orioles, but special permits may be obtained to kill them if you can show they are causing damage.

For a permit, contact the permit office, Canadian Wildlife Service, Environment Canada, at 905-336-4464.

Pyrotechnic pistol cartridges are also available with delayed explosions and/or sustained whistles that disorient and frighten birds.

Propane-fired bird scaring cannons

Cannons are one of the most commonly used bird scaring devices. Loud, unexpected gunshot-like sounds, produced at random intervals, cause birds to flee. Move the cannons periodically to different locations in the orchard or vineyard. Birds quickly adjust their feeding habits if cannons are in the same location throughout the harvest season.

A major drawback of these devices is the disruption to neighbours. Growers must recognize this and adjust usage to minimize discomfort to neighbours. Most neighbours are sympathetic to the need for crop protection, but may complain if the equipment is not used properly.

- Fire cannons only during bird forage periods in daylight hours, generally accepted as 30 minutes before sunrise and 30 minutes after sunset. Check the local newspaper or radio for sunrise and sunset times in your area. Operation outside these times is not considered a normal farm practice.
- Place cannons as far away from neighbours as possible and at least 125 m away from their houses.
- Operate cannons on the Frequency 2 setting, meaning the firing sequence occurs randomly during a 4–8-minute span.

- Do not place cannons closer than 75 m apart.
- Make sure cannons are level so they fire in all directions uniformly.
- Monitor the equipment regularly to ensure it functions properly.

For more information on bird scaring cannons, see OMAF Factsheet, *Using Propane-Fired Cannons to Keep Birds Away from Vineyards*.

Electronic sound devices

This equipment emits electronic or other types of sounds that imitate distress or predator calls of different bird species. The sound produced, although loud, is usually less objectionable to neighbours than propane-fired cannons.

- Operate electronic sound devices only during daylight hours.
- Move the equipment periodically for maximum effectiveness.

Chemical controls

Currently, there are no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals.

Visual deterrents

These include: aluminum foil hung in trees, model hawks and other birds of prey, strips of yellow plastic hung along vineyards, vibrating plastic strips, scarecrows, mirrors, kites and scare-eye balloons. Most visual deterrents move with the wind, produce noise and make reflections. Other visual deterrents on trial in Ontario include the use of lasers to disperse birds and robotic scaring devices activated by bird movement.

Falconry

Trained falcons and hawks provide successful bird control. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks of this approach for fruit growers.

Control of Southwest Injury on Fruit Trees

Southwest injury, or winter sunscald, occurs in the winter and is especially severe when cold still nights follow cold sunny days. This phenomenon can occur

in apple, peach, pear, cherry, plum, apricot and tree nut orchards. The damage is usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark and underlying tissues may occur. This injury usually affects large portions of the bark tissue that become brown and eventually slough off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees. Recent increases in apple tree cankers may also be linked to problems with southwest injury in the winter.

Paint the trunk, crotches and lower parts of main scaffold branches thoroughly with exterior white latex paint to minimize southwest injury. The white paint reduces the damage by reflecting direct sunlight from the exposed tissue. This helps to reduce rapid warming on sunny days when air temperatures are below freezing.

- Avoid oil-based or latex paints that contain any oil. These products contain toxic materials that may injure or kill fruit trees.
- October is the best time to apply the paint. For best results, paint trees on days when the temperature is above 10°C and when the paint or spray will dry rapidly.
- Apply the paint by brush or spray. If you choose spray, dilute the paint with 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available.
- On young trees, paint the whole trunk. Only the south and southwest sides of older trees require paint. The whiter the bark after you paint, the greater the protection. Better quality paints are more durable.
- On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available products which reflect sunlight and repel rodents (e.g., Skoot). Avoid contact with eyes, skin and clothing with products containing thiram.
- Do not use the thiram-latex mixture if you plan to use a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown and reducing its

effectiveness as a heat reflector. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture.

Heat Stress and Sunburn on Apple and Pear Trees

Surround WP is highly refined kaolin clay. Applied to the tree canopy, it forms a microscopic particle film that protects both leaves and fruit from high UV light and heat, which can slow the photosynthetic rate in a tree canopy.

The benefits of using Surround on young apple and pear trees during their establishment include:

- greater net accumulation of carbon from photosynthesis
- enhanced fruit bud initiation
- increased trunk diameter
- increased shoot growth

In established orchards, trees treated with Surround have healthier foliage through to leaf drop. Plant dormancy is not affected. Fruit finish and marketable yield are improved on several cultivars.

To prevent heat stress, make 2 applications of Surround, 7 days apart, using 50 kg/ha. Begin spraying before heat stress is likely to occur. Continue applications at 7–14-day intervals at a reduced rate of 25 kg/ha to maintain even coverage.

Precautions when using Surround:

- Do not mix Surround with spreaders, stickers or anti-foaming agents.
- Do not spray when bees are active.
- In orchards treated with Surround, monitor fruit maturity carefully and use starch iodine tests in the last 2 weeks of crop development.

For information on using Surround to suppress crop pests, see *Organic and Biopesticide Products*, page 241.

OTHER PESTS AND DISORDERS

9. Organic and Biopesticide Products

Organic and Biopesticide Products

Organic pest control products are pesticides that are approved for use in organic production. For organic products, both the active ingredient and all additional ingredients must be derived from natural sources (typically biological or botanical).

All organic pest control products must meet the requirements of the Canadian Organic Standards, and any additional requirements of the local organic certification body. Products included in one of the organic lists mentioned in Table 9-1, *Organic and Biopesticide Products Used on Fruit Crops*, page 243, may be acceptable. However, growers should always confirm with their certification body that any product being considered is acceptable in their particular situation.

Biopesticides are pest control products derived from natural materials such as animals, plants, and bacteria. In Canada, biopesticides are divided into two major classes: microbial and biochemical pesticides.

- **Microbial pesticides** contain a beneficial bacterium, fungus, virus or protozoan as the active ingredient. They are relatively specific to their target pest. Examples include the various subspecies and strains of *Bacillus thuringiensis*.
- **Biochemical pesticides** are naturally occurring substances and/or manufactured molecules that resemble naturally occurring substances. They generally control pests by different mechanisms than conventional pesticides, such as disrupting insect mating (e.g., Isomate) or by making crops unsuitable for feeding (e.g., Surround). While many biopesticides are less toxic and pose a lower risk than conventional pesticides, some may be quite toxic.

It is important to be aware that not all biopesticides are organically acceptable and that not all organic products are biopesticides. In some cases, the active ingredient may be organic, but it may be formulated with other ingredients that are not acceptable for organic production (e.g., some formulations of the bacteria *Bacillus thuringiensis*). Similarly, there are organic pest control products that do not meet the definition of a biopesticide (e.g., copper).

Pest Management in Organic Production

Pest management in organic fruit production involves the use of numerous control strategies aimed at preventing pest problems before they appear. In organic production, pest control products should be used as a last resort, only when other management practices have not been sufficient to prevent the pest from causing economic damage to the crop.

Cultural controls

Cultural controls are practices that make the cropping environment less favourable to the development of pests, including:

- **Site selection** – Choose sites less favourable for pest development.
- **Crop rotation** – Plant non-related crops in successive years to minimize the chance of plant-specific pests building up in the soil.
- **Cover crops** – Use cover crops to add organic matter, improve soil structure, or reduce pest populations, depending on the type of cover crop. See *Cover Crops*, page 23 for more detail.
- **Resistant varieties** – Some varieties can be more tolerant in their response to pests. When available, select varieties known to be resistant to the particular pests present in your area.
- **Crop health** – Keep the crop healthy by maintaining optimum nutrition, plant moisture levels, plant population densities and soil conditions to help plants resist or tolerate pests.
- **Adjust planting or harvest dates** – If you know the biology of the pest attacking your plant, time planting or harvest to avoid damage.
- **Sanitation** – Remove material (e.g., weeds or plant debris) that allows pests to survive or be transported between plants or crop, plant only high quality nursery material known to be free of insects and diseases, and take appropriate measures to avoid transferring pests between plants or fields on contaminated tools, farm equipment or worker clothing.

- **Crop diversity** – A wide variety of plants grown in a small location can impede the movement of flying insects or the spread of disease, as well as provide a habitat for beneficial insects. This can be achieved by intercropping, farmscaping or other methods.
- **Trap crops** – Keep insect pests out of the crop by planting preferred hosts along borders or between crop rows. Make sure to manage trap crops to prevent movement of the pest back into the commercial crop.

Mechanical controls

Mechanical control methods are those that physically remove the pest, or otherwise prevent it from injuring the crop. These can be effective, but have a high cost. Strategies selected must be suited to the crop situation and scale of production.

- **Physical removal** – Physically remove pests by hand, dislodge them with strong jets of water, prune diseased plant parts, use vacuums or other means.
- **Mulches** – Use covers (wood chips, fabrics, plastics, etc.) on the soil surface to help for weed control, or in some cases to deflect certain insects.
- **Row covers or other barriers** – Construct barriers around and over plants to help protect them from pest attack.

Biological controls

Biological control involves using a pest's natural enemies ("beneficials") to help suppress it. These may be predatory insects, parasites, pathogens or nematodes.

- **Promoting beneficial insects** – Promote and attract natural enemy populations by providing them with favourable habitat, and avoid pesticides that negatively affect them.
- **Augmentation** – Release of natural enemies into a crop for biological control has been very successful in greenhouses. This method may have less value in crops grown outdoors where it is difficult to contain introduced natural enemies.

While use of these strategies to prevent pest problems is a requirement for organic producers, they are also the basis for integrated pest management in any production system. More information can be found on the OMAF website at www.ontario.ca/crops.

Organic Products in Conventional Production

While organic and biopesticide products are used most widely by organic producers, they can be a useful tool for conventional growers as well. Possible advantages for conventional producers include:

- lower potential for pest resistance
- providing a rotational option to help manage resistance development in other conventional products
- shorter re-entry intervals
- shorter preharvest intervals
- potentially lower toxicity to non-target organisms

While organic products and biopesticides can be helpful additions to IPM programs, they may not provide the same high level of control as conventional pesticides. Biopesticides are often labelled for suppression, or partial suppression, of pests (see Table 11-1. *Pesticide Efficacy Ratings*, page 267). To improve control, combine their use with the other pest control tactics mentioned in the previous section.

Using Organic and Biopesticide Products

Although many organic and biopesticide products are formulated, packaged and applied in a very similar fashion to conventional pesticides, the active ingredients are different. They have unique, specialized modes of action which make them more susceptible to numerous biological and environmental factors.

Some of the possible challenges associated with using these products are:

- more frequent applications needed to control pests
- slower acting than conventional pesticides
- may provide suppression but not control of the pest
- more expensive than conventional pesticides
- fewer pests controlled

Table 9-1. *Organic and Biopesticide Products Used on Fruit Crops*, page 243, provides details on important factors that affect the success of these pest control products. Refer to product label for details and application instructions. Knowing the specific requirements for these products can improve the success of their use.

Table 9-1. Organic and Biopesticide Products Used on Fruit Crops

This information does not replace that included in product labels. Always check the label before use. Products listed as potentially acceptable for organic use are those included in either: (1) the Canadian database of brand name inputs for organic production (www.organicinputs.ca), (2) the 2013 Atlantic Canadian Organic Regional Network (ACORN) directory of organic inputs (acornorganic.org/index.html), or (3) the Organic Materials Review Institute (OMRI) Canada (www.omri.org/omri-canada). **Organic growers must always check with their certifying bodies to verify the acceptability of any product listed below prior to using them.**

Product Name	Potentially Organic/ Biopesticide ¹	Labelled Crops ²	Spray Timing	Environmental Effects ³	Comments
Insect/Mite Controls					
Bacillus thuringiensis (Bt)					
Bioprotec CAF	O, B	CG 13-07, apple, apricot, cherry, grape, hazelnut, peach, pear, pecan, sweet chestnut, walnut	young larvae, early infestation	UV, rain	Spray water pH should be less than 8. Agitate during spraying. Must be ingested by insect to be effective. Spray when and where pests are actively feeding. Death may take several days. Spray mix should be used within 12 hours (Dipel) or 18 hours (Bioprotec, Foray). Bioprotec CAF should be stored at 0 to 15°C and used within 6 months of date of manufacture.
Dipel 2X DF	O, B				
Foray 48 BA	NL, B	apple, blueberry, pear, raspberry			
Cydia pomonella granulovirus					
CYD-X	NL, B	apple	eggs/young larvae	UV, rain	Must be ingested to be effective – apply where/when larvae are feeding. Sprays are only effective for about 1 week. To increase effectiveness, use with other materials, such as mating disruption for organic or other active ingredients for conventional growers. Use non-chlorinated water at pH near 7 in spray tank. Store product at 4°C.
Virosoft CP4	O, B				
Ferric phosphate					
Sluggo Professional	O, B	fruits and berries	when slugs are active	rain	Apply to soil that is moist but without standing water. Wet very dry soil prior to application. Apply in the evening to areas likely to be infested with slugs and snails (e.g., damper areas). Use high rate with heavy rain or irrigation. For trees, apply with standard granular fertilizer spreaders. For berries, apply by hand or with granular spreaders to furrows near base of plants. Do not place in piles.
Insect pheromones					
Isomate CM/OFM TT	O, B	apple, pear, walnut	prior to adult activity	—	Store product at 4°C until use. Pheromones have specific instructions for use which depend on target pest and crop. See section on <i>Mating Disruption in Fruit Crops</i> , page 250.
Isomate DWB	NL, B	apple, hazelnut, pear, pecan, sweet chestnut, walnut			
Isomate-GBM Plus	O, B	grape			
Isomate-M 100	O, B	apple, apricot, peach, pear			
Isomate-M Rosso	O, B				
Isomate-PTB Dual	O, B	apricot, cherry, peach, plum			

¹ O = Products that may be acceptable for use by organic growers, as indicated by lists described above. (Always confirm status with certifying body prior to using product). NL = Product is currently not included on organic lists described above. B = Product is considered a biopesticide in Canada.

² Labelled Crops = Fruit crops included on product label. Not all pests are problems on these crops in Ontario. Products should be used only for pests listed on the label. See Appendix C: *Crop Groupings for Pesticide Registrations in Canada*, page 293 for full listing of crops within each crop group (CG).

³ UV = Active ingredient may be inactivated/broken down by sunlight or is more effective when conditions favour slow drying. Spray in early morning, early evening or when cloudy. Rain = Efficacy is reduced or product is readily washed off by rain. Avoid application when significant rainfall is imminent or do not apply to foliage wet to the point of runoff. Heat = Short residual activity under hot, dry conditions. — = Information is not available.

Table 9-1. Organic and Biopesticide Products Used on Fruit Crops (cont'd)

Product Name	Potentially Organic/ Biopesticide ¹	Labelled Crops ²	Spray Timing	Environmental Effects ³	Comments
Kaolin clay					
Surround WP	O, B	apple, grape, hazelnut, pear, pecan, raspberry, strawberry, sweet chestnut, walnut	early infestation	rain	Efficacy depends on complete coverage of leaves and fruit. Light to moderate rain will help distribute product. Re-application may be necessary after heavy rain, wind, overhead irrigation or new growth. Do not spray when bees are active. Leaves white film on plant parts – stop applications once fruit is sizing if crop will not be washed and waxed. May delay sugar accumulation. Monitor closely to determine best time to harvest. Do not apply postbloom to table grapes. Do not use with anti-foaming agents, white mineral particulate products, spreader/stickers or summer oils.
Mineral oil					
Purespray Green Spray Oil 13E	O	apple, apricot, highbush blueberry, grape, pear, peach, plum, cherry	early infestation	rain	Product must cover pest to be effective. Thorough coverage essential. Oils may cause plant injury – follow labels carefully for precautions. Do not use within 48 hours of freezing temperatures or when temperatures are above 25°C. Do not use within 14 days of Supra Captan, Maestro, Folpan or any sulphur product.
Superior 70 Oil	O				
Potassium salts of fatty acids (insecticidal soaps)					
Opal	O	fruit trees (including apple, apricot, cherry, nectarine, peach, pear, plum), nut trees (including hazelnut and walnut), small fruit (including blueberry, grapes, raspberry, strawberry)	early infestation	UV	Agitate tank mixes during spray. Product must contact pest directly to be effective and has no effect once spray deposits have dried. Thorough coverage essential. Repeat applications may be needed; however, do not allow soap to accumulate at base of fruits. Do not mix with Manzate or Dithane. Do not use within 3 days of sulphur. Do not apply to stressed plants.
Pyrethrin					
Pyganic EC 1.4 II	O, B	blueberry, grape, raspberry	early infestation	UV	Do not use when bees or other beneficials are present. Product has short residual activity – repeat applications may be required after 7 days. Apply in early morning or late evening. Adjust spray solution to pH of 5.5–7.0 and avoid tank-mixing with other products that can affect spray mix pH.
Spinosad					
Entrust 80 W	O, B	CG 11, CG 12, CG 13-07A, CG 13-07B, CG 13-07G, grape, walnut	depends on pest; see label	UV	Product kills primarily by ingestion so coverage is important. Do not use when bees are present.
Entrust SC	NL, B	CG 11, CG 12, grape			

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² Labelled Crops = Fruit crops included on product label. Not all pests are problems on these crops in Ontario. Products should be used only for pests listed on the label. See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

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Table 9-1. Organic and Biopesticide Products Used on Fruit Crops (cont'd)

Product Name	Potentially Organic/Biopesticide ¹	Labelled Crops ²	Spray Timing	Environmental Effects ³	Comments
Spinosad + bait					
GF-120 Fruit Fly Bait	O, B	apple, blueberry, cherry, walnut	adult trap catch	rain, heat	Do not use when bees are present. Large droplet sizes optimize the attractiveness of the bait. Apply using an all-terrain vehicle fitted with an appropriate sprayer and nozzle to ensure large drops. Re-apply every 7–10 days or after rain.
Disease Controls					
<i>Aureobasidium pullulans</i> strains DSM 14940 and 14941					
Blossom Protect	NL, B	CG 11-09	1–2 days before infection risk	—	Rate is dependent on tree height – for every 1 m of tree height, dilute 5.25 kg of Component A in 500 L/ha water and add to 0.75 g Component B. May increase fruit russetting on sensitive varieties if applied more than 2 times. Do not tank-mix or apply within 2 days of captan, dodine, strobilurin or copper fungicides, as these are toxic to the yeasts. Use in rotation with streptomycin to reduce risk of resistance. Store product up to 10 months at room temperature (20°C) or up to 24 months at 8°C.
<i>Bacillus subtilis</i>					
Serenade MAX	O, B	CG 11, CG 12, CG 13A, CG 13B, grape, saskatoon berry, sea buckthorn, strawberry	early disease development	—	May not provide complete control – use in conjunction with other cultural or chemical controls. When conditions are conducive to high disease pressure, rotate with other fungicides.
Citric acid + lactic acid					
Tivano	O, B	grape, strawberry	when conditions favour disease development	—	Thorough coverage of top and bottom leaf surface essential. Coverage can be improved by using a non-ionic surfactant and flat-fan nozzle tips. Use preventatively or in rotation with other fungicides. May cause injury to other plants if not mixed or applied according to label instructions.
Copper products (copper sulphate, copper oxychloride, copper hydroxide)					
Copper 53 W	O	see Table 9-2. Copper Products for Use on Fruit Crops, page 254	preventative	—	Copper products are non-systemic and have no effect on pathogens that have already invaded plant tissue. Repeat applications will be required to protect new growth. For detailed instructions on using copper, see the section on copper products, starting on page 253.
Copper Spray	O				
Guardsman Copper Oxychloride 50	O				
Kocide 2000	NL				

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Table 9-1. Organic and Biopesticide Products Used on Fruit Crops (cont'd)

Product Name	Potentially Organic/ Biopesticide ¹	Labelled Crops ²	Spray Timing	Environmental Effects ³	Comments
Garlic powder					
Buran	NL, B	apple, grape, pear	early disease development	rain	Time applications for after rain or periods of prolonged leaf wetness, when conditions are conducive to disease development. Repeat applications and thorough coverage required for efficacy. For apple scab, apply at green tip to tight cluster for primary infections and systematically for secondary infections. This is a new product in Ontario and little evidence of its efficacy is available.
Lime sulphur					
Lime Sulphur	O	apple, blueberry, gooseberry, grape, pear, peach, strawberry, raspberry	delayed dormant and preventative	---	Do not spray when foliage is wet. Thorough coverage essential. May cause leaf damage, particularly when applied in the calyx or early summer. Also labelled for scale/mite control and general cleanup on some fruit crops.
Mineral oil					
Purespray Green Spray Oil 13E	O	apple, apricot, cherry, grape, peach, plum, nectarine	at first sign of disease	rain	See comments for Mineral oil under Insect/Mite Controls on page 244.
Oriental mustard seed meal					
MustGrow	NL, B	raspberry, strawberry	early spring when soil is cool but above 10°C	—	Allow at least 2 weeks between treatment and planting. Incorporate into upper layer of soil to a depth of 10–15 cm and follow with irrigation to activate product.
Pantoea agglomerans					
Bloomtime Biological FD	O, B	apple, pear, raspberry, saskatoon berry	first spray at 15–20% bloom	---	Thorough coverage is important. Do not use close to copper sprays. Repeat applications will likely be required. Store product between -10° and 0°C.
Potassium bicarbonate					
MilStop	O, B	apricot, grape, peach, plum	at first sign of disease	rain	Use high rate and shorter intervals when conditions are conducive for disease development. Do not acidify spray solution or adjust pH after preparing spray mix. Do not mix with other chemicals not compatible with mild alkaline solutions, or add surfactants or wetting agents. Thorough coverage essential. Short residual – repeat application may be required.
Sirocco	NL, B				
Pseudomonas syringae					
Bio-Save 10 LP	NL, B	postharvest (apple, cherry, pear)	within 24 hours of harvest	---	Apply as an aqueous drip, drench or spray after washing and rinsing but prior to waxing. Thorough coverage essential. Agitate suspension during application. Store up to 3 weeks at 23°C or up to 1 year at 4°C.

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Table 9-1. Organic and Biopesticide Products Used on Fruit Crops (cont'd)

Product Name	Potentially Organic/Biopesticide ¹	Labelled Crops ²	Spray Timing	Environmental Effects ³	Comments
<i>Reynoutria sachalinensis</i> extract					
Regalia Maxx	O, B	grape, strawberry	when conditions favour disease development	—	Use higher rate and shorter intervals when conditions are conducive for disease development. Repeat applications may be required. For grapes, do not use as a solo powdery mildew product from prebloom through berries pea-sized stage – use 0.125% in a tank mix or rotation with other powdery mildew fungicides.
<i>Streptomyces lydicus</i>					
Actinovate SP	O, B	blueberry, grape, strawberry	when conditions favour disease development	rain	Use higher rates or shorter intervals when conditions are conducive for disease development. Use spray mix within 4 hours of preparation. Do not combine with other pesticides (especially bactericides), adjuvants, surfactants or fertilizers. Thorough coverage essential. Repeat applications every 7–14 days. Can be stored at room temperature but should not be frozen or exposed to high temperatures.
Sulphur					
Kumulus DF	O	apple, cherry, grape, pear, peach, plum, saskatoon berry	—	—	Sulphur can be phytotoxic under certain conditions. Do not use on sulphur-sensitive varieties. Do not use when high (>25°C) temperatures are expected during the 3 days after application. Be cautious when using sulphur products close to sprays of certain other pesticides, such as oils or copper – refer to product label for specific instructions. Some product labels also list control of certain mite or scale pests on some crops.
Microscopic Sulphur	O	apple, cherry, currant, gooseberry, grape, peach, pear, plum	prior to or at first sign of disease development	—	
Microscopic Wettable Sulphur	O	apple, cherry, grape, peach, pear, plum	—	—	
Microthiol Disperss	NL	apple, cherry, grape, peach, pear, plum, saskatoon berry	—	—	

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Organic and Biopesticide Products for Insect Control

Bacillus thuringiensis var. *kurstaki* (Bioprotec CAF, Dipel 2X DF, Foray 48BA)

Bacillus thuringiensis products are registered for control of various caterpillars, including leafrollers and fruit worms. The active ingredients in these products are proteins produced by the bacteria *Bacillus thuringiensis*, or *Bt*. *Bt* is commonly found in soil, dead insects, plants and other locations. There are many subspecies, and some have proteins that are toxic to specific groups of insects. The *kurstaki* subspecies is toxic only to caterpillars, although it is not equally effective against all species of caterpillar. Insects affected by *Bt* stop feeding within a few hours and die in 2–5 days.

Because the product must be consumed, thorough coverage is essential. Evening applications may be particularly important if the target pest feeds predominantly at night. Younger larvae are more susceptible to these products. These products have short residual activity, so repeat applications will often be required. Do not apply in high volumes of water. For example, use no more than 600 L water/ha for Bioprotec and Foray.

Crop-specific strategies

Apple – Due to their photosensitivity, *Bt* products are often used early in the season prior to petal fall. However, they can be used later in the season to manage obliquebanded leafroller where populations are low.

Grape – When hatching, larvae must consume eggshell treated with *Bt* in order for the product to be effective. Apply *Bt* to coincide with grape berry moth egg hatch, earlier than the traditional timing for organophosphate and pyrethroid insecticides.

Cydia pomonella granulovirus (CYD-X, Virosoft CP4)

The *Cydia pomonella* granulovirus is a naturally occurring pathogen which is highly specific to codling moth larvae. Ingested virus particles invade the gut wall, attacking and degrading the insect's tissues. The insect eventually stops feeding and dies 2–5 days later. Since larvae must ingest the virus to be infected, damage to fruit may occur before the insect dies.

Apply granulovirus when young larvae either are on the surface of the fruit or will encounter the virus before entering the fruit. The best method is to have the virus

present on the eggs, so the virus particles are consumed as the codling moth larvae hatch. If granulovirus is to be the only control, apply the first application at 139 DDC, base 10°C after biofix (first sustained moth catch), followed by subsequent applications to cover the egg hatch period.

These products are most effective when used in conjunction with other materials. One option would be to apply a chemical insecticide at the start of egg hatch (139 DDC, base 10°C after biofix), with the virus serving as the second spray, when more eggs are present to be covered by the virus. Follow this with another rotation of insecticide and virus, or simply with additional applications of the virus.

Another option is to target only the first generation with the virus product. Although some virus-infected larvae will not die immediately, very few of these larvae will actually pupate and emerge as summer generation adults. Using this active ingredient for the first generation greatly reduces the size of the summer generation, which can be controlled with other pesticides.

Ferric phosphate (Sluggo Professional)

Sluggo Professional is registered for control of certain species of slugs and snails in fruit and berry crops. It consists of the active ingredient ferric phosphate, a compound commonly found in soils, formulated in a bait. When snails or slugs eat the bait, the active ingredient damages their digestive tissue, causing them to rapidly stop feeding, and die within 3–6 days.

Kaolin clay (Surround WP)

Surround WP is based on kaolin clay, a non-toxic compound which protects crops from certain insects, heat stress and sunburn by coating plant surfaces with a white particle barrier film. This barrier repels and disorients insects, making the host plant unrecognizable for feeding.

Crop-specific strategies

Apple – In orchards treated with Surround, use starch iodine tests to monitor fruit maturity in the last 2 weeks of crop development. Check with your packer before using Surround on fruit for export to Europe. Applications at petal fall may interfere with leaf miner parasitism, requiring additional control measures.

Grape – Surround may delay sugar accumulation. Closely monitor harvest parameters to determine optimal time to harvest.

Raspberry and Strawberry – Avoid application when fruit is present. Surround is most useful for potato leafhopper control in non-bearing plantings.

Mineral oil (Purespray Green Spray Oil 13E, Superior 70 Oil)

Mineral oil is a highly refined petroleum product that is different from dormant oil. Purespray Green Spray Oil 13E is also registered for the control or suppression of certain diseases. Mineral oil acts as an insecticide/miticide by suffocation and is effective only when the film deposited covers every scale or mite. Eggs are most vulnerable to control with oil just before hatching.

Do not use oil within 14 days before or after Supra Captan, Maestro, Folpan or any sulphur product.

Crop-specific strategies

Apple – Bark injury caused by oil may occur on Red Delicious, Empire and Mutsu. Oil will provide control of overwintering ERM and suppression of summer populations of ERM and powdery mildew.

Grape – Oil provides significant eradicant activity against existing infections. However, this product works strictly by contact, hence thorough spray coverage is essential.

Do not tank-mix oil and copper more than once per season. Do not use copper and oil together with fruit present. In research trials, 2 or more applications of oil near veraison have resulted in a modest but consistent lowering of Brix values (1–2°) at harvest. In contrast, applications before this period generally have had no effect on Brix values.

Stone fruit – Oil may be used for cherry mildew management between petal fall and pit hardening. Do not apply between pit hardening and harvest. Certain varieties of plums and prunes may be injured by oil sprays. Check for tolerance prior to treatment. Do not apply oil to sensitive varieties. Do not apply to trees under moisture stress. Postharvest sprays may be made to maintain control and reduce overwintering powdery mildew pressure.

Potassium salts of fatty acids/Insecticidal soap (Opal)

Insecticidal soaps are registered for control of aphids, scale and other soft-bodied insects and mites. They work by coating the bodies of soft-bodied insects, smothering them and interfering with their cuticles. Thoroughly cover all plant parts, including under leaf surfaces,

where soft-bodied insects such as aphids are found. Apply these products when drying conditions are slow, in the early morning or evening, or when it is cloudy.

Insecticidal soaps often will not give complete control because it is difficult to cover 100% of the pests present in a crop. They are generally most effective when pest populations are small. Combine the use of insecticidal soaps with other pest management techniques (other chemicals or cultural controls).

Pyrethrins (Pyganic EC 1.4 II)

Pyganic is a botanical insecticide registered for control of aphids and leafhoppers. The active ingredient, pyrethrum, is a mix of compounds produced by chrysanthemums which act on the nervous system of insects, inducing paralysis. Pyrethrum is also the precursor to synthetic pyrethroid insecticides, which are widely used in conventional agriculture, but not permitted for organic. Unlike many other organic products, Pyganic is relatively broad-spectrum, and may have negative effects on beneficial insects as well as the target pest. However, Pyganic is also rapidly broken down by sunlight and thus has a short residual activity on plants, so it is considered less harmful to beneficials than conventional pyrethroids.

Spinosad (Entrust 80 W, Entrust SC)

Entrust is registered in a number of fruit crops for control of various insect pests. Note: other similar formulations (e.g., Success, Delegate) are not organically acceptable. The active ingredient, spinosad, is derived from the fermentation of the soil bacterium *Saccharopolyspora spinosa*, although further chemical modification occurs after fermentation in the production of spinetoram. It kills susceptible insects by rapidly exciting their nervous symptoms, causing them to essentially die of exhaustion within 1–2 days of ingestion. Although it kills insects primarily by ingestion, it is partly taken up in leaf tissue, which enhances its effectiveness over time. Direct contact with spinosad is toxic to honeybees.

Spinosad + bait (GF-120 Fruit Fly Bait)

GF-120 is registered for control or suppression of various maggot pests. It is not considered a biopesticide; however, it is similar to a biopesticide in having a unique formulation that requires special consideration to optimize efficacy. The active ingredients are spinosad, which is derived from the fermentation of the soil bacterium *Saccharopolyspora spinosa*, plus a feeding attractant that serves as a bait to draw adult flies to the product. Because the bait attracts insects to the spray deposits, only a small amount of insecticide is required.

It has low toxicity to mammals and birds, but is toxic to adult flies of various pest species, exciting their nervous symptoms and causing death from exhaustion within 1–2 days of ingestion. Direct contact with spinosad is toxic to honeybees.

Crop-specific strategies

Apple – Research conducted in Ontario has shown suppression of apple maggot in organic orchards. However, GF-120 does not provide adequate management of this quarantine pest in orchards where there is zero tolerance for damage. Monitor apple maggot emergence using sticky traps and apply GF-120, at a rate of 1.5 L per 6 L water, after the first fly is caught. To improve efficacy, prune trees to ensure penetration of the product to the cooler, shaded inner canopy where its residual activity may be prolonged. Uniform spray coverage of foliage is not critical.

Blueberry – Begin application when first blueberry maggot flies are trapped, or when berries begin to turn blue (about 2–3 weeks before fruit begins to ripen). Repeat application at least every 7–10 days.

Cherry – Spray as soon as traps indicate flies are present or 2–3 weeks before ripening.

Mating Disruption in Fruit Crops

Insect pheromones developed to reduce populations of certain pests are considered biopesticides by the Pest Management Regulatory Agency (PMRA).

Many female insects emit volatile chemicals known as sex pheromones to attract males of the same species. Mating disruption products release large quantities of synthetically produced sex pheromone into the crop atmosphere, which confuses male insects and interferes with mate location. Consequently, fewer larvae develop as mating is either delayed or prevented and crop damage is reduced.

Managing insects using mating disruption is very different from using insecticides. Mating disruption products are highly specific, targeting a single or few very closely related insect pests. They do not kill the target pest, nor will they control immigration of mated females from untreated or poorly managed areas. Mating disruption products must be applied before adults begin to fly. Late applications allow some mating to occur, with subsequent damage to the affected crop. Where pest populations are moderate to high, some mating will occur due to random chance encounters between males and females. Mating disruption works most effectively where the target pest populations are low.

When applied to a block over multiple years, mating disruption products reduce overall population pressure so that insecticides may be reduced or, in some cases, eliminated.

The many advantages of using mating disruption include improved safety to humans and non-target organisms, resistance management, and no re-entry or preharvest intervals.

Limitations include a requirement for large, regularly shaped blocks, low to moderate pest pressure, and the need for insecticides for other orchard or vineyard pests.

Wild or unsprayed hosts (i.e., wild grapes, abandoned orchards) within 300 m of areas where mating disruption is used can be major sources of mated female moths. Moths moving from these untreated areas into treated areas may significantly reduce the level of control achieved.

To overcome this problem:

- Treat entire blocks with pheromones or practise area-wide management to reduce border effects.
- Treat infestation sources with a registered insecticide or with appropriate mating disruption product (e.g., treat a strip at least 50 m wide nearest the treated field).
- Treat border rows of the pheromone-treated block with insecticide.

There are several mating disruption products available for use in orchards and vineyards. While general use strategies remain similar for each, some are more effective than others at keeping damage at or below economically acceptable thresholds. As with insecticides, mating disruption programs are not stand-alone strategies for all pests. Every orchard has different pest pressures, which affects the successful integration of mating disruption into IPM programs.

For more information, see OMAF Factsheet, *Mating Disruption for Management of Insect Pests*.

Mating disruption for oriental fruit moth (Isomate-M Rosso, Isomate-M 100)

If using mating disruption products for the first time or in areas of high pest pressure, use an insecticide to manage the first generation of oriental fruit moth (OFM). For late-harvest varieties located near untreated areas or host crops, application of insecticides may be required.

Monitor treated blocks with OFM pheromone traps to ensure moths are not being captured – a sign of some level of failure or weakness in the mating disruption program.

Routinely look for signs of damage from OFM. If unacceptable levels of damage have occurred, use insecticides until the source of the failure has been determined.

For more information, see OMAF Factsheet, *Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit*.

Mating disruption for codling moth and oriental fruit moth (Isomate-CM/OFM TT)

Mating disruption alone will not provide adequate control of codling moth (CM) in most commercial orchards. When used together with existing IPM programs, pest populations and pesticide use can be reduced over a number of seasons.

- During the first year of using mating disruption for CM, follow a standard spray program for both generations and monitor extensively for this pest.
- In the second year of a mating disruption program, and where populations are low, limit insecticides to the first generation.
- In subsequent years, use results from monitoring and damage assessments to determine if insecticide applications can be reduced further when mating disruption products are used.

Many of the new reduced-risk products and the granulovirus (Virosoft, CYD-X) work very effectively together to reduce CM populations to levels where insecticide use may be reduced in subsequent years.

Apply Isomate-CM/OFM TT (twin tubes) prior to CM emergence in the spring. Set dispensers in the upper third of the canopy, in a uniform grid. In older orchards interplanted with small numbers of replacement trees, bias the application to adjacent larger trees. In sections with large numbers of interplanted rows, insecticides may be required to supplement control from mating disruption.

The dispenser is designed to provide activity for the entire season for CM. While some OFM may have emerged prior to deployment of the dispensers, several petal fall insecticides have activity against this pest. Dispensers release sufficient pheromone to control OFM for up to 90 days. Insecticides may be needed in late varieties when high OFM populations exist or when immigration from untreated blocks late in the season may occur.

Monitoring for codling moth flight in mating disruption blocks

Codling moth populations in disrupted orchards must be monitored to determine pest pressure and the need for supplemental insecticides. Because the high concentration of pheromone used for mating disruption masks traps loaded with standard lures, specialized lures are needed. The industry standard is the CM DA Combination Lure, which contains a chemical extracted from ripe pears to attract both male and female codling moths. These lures last up to 8 weeks.

Traps should be placed in the upper third of the canopy in disrupted blocks (same height as the mating disruption dispensers). Use a minimum of 1 trap per hectare, with traps located near high-risk areas and borders (5–6 rows in).

Thresholds for the application of insecticides are based on the number of moths captured per trap per week in disrupted blocks. As a general guideline, 3–5 moths per trap per week indicate a need for caution. More than 5 moths per trap per week indicate the need for insecticides to supplement control from mating disruption. Do not average the number of moths per trap per week. Trap captures are an indication of potential local hot spots.

Damage assessments

Conduct in-season visual assessments for fruit damage toward the end of each generation and whenever moths are caught in traps. Fruit damage can occur even when no moths are caught in traps.

At the end of the first CM generation, examine a minimum of 500 fruit from throughout the orchard as well as in high-risk and border areas. If damage exceeds 0.5%, insecticides are required for the next generation. Where damage is localized, insecticides may be directed to those areas and along borders. Continue to assess damage weekly (200 fruit) throughout the season, to ensure the pheromones are working and to allow for timely intervention with insecticides, if required.

Mating disruption for grape berry moth (Isomate-GBM Plus)

Mating disruption works best in vineyards with low grape berry moth (GBM) populations. Avoid using mating disruption next to vineyards with known high populations. Vineyards should be at least 2 ha in size.

To use Isomate-GBM Plus, place the recommended rate of pheromone dispensers uniformly through the vineyard prior to, or at the onset of first flight of moths in spring. Delayed application results in increased mating and reduced control. Attach dispensers securely to the highest trellis wire.

Conduct damage assessments throughout the season to ensure that GBM are adequately controlled.

Monitoring for grape berry moth

Use 5 pheromone traps for vineyards up to 5 ha in size. These traps are used as sentinels: captures of moths in pheromone traps should be very low to zero in vineyards using mating disruption.

- Place traps along a line that transects the vineyard or at the 4 corners of the vineyard.
- Place at least 1 extra trap along the windward edge of the vineyard.
- Where vineyards are located adjacent to wooded areas, place traps within the border area at least 40 m apart.

Damage assessments

Closely inspect fruit weekly in the outer 5 panels and rows for infestation, especially on the windward side.

- If more than 5% of the grape clusters in this outer area are infested with GBM larvae, continue sampling another 5 rows and panels in.
- If more than 5% of the grape clusters in the outer 5 rows but less than 5% of grape clusters in the inner 5 rows are infested, then apply an insecticide to the border of the vineyard.
- If more than 5% of grape clusters in the inner 5 rows are infested, apply an insecticide to the entire block.

Mating disruption for dogwood borer (Isomate-DWB) and peach tree borer (Isomate-PTB Dual)

Immigration of mated females into the orchard from adjacent areas will reduce control. Supplemental insecticides may be required for several years to help bring populations down to levels where mating disruption can be used alone for management of borers. Use higher rate of dispensers for the initial treatment year.

For dogwood borer:

- Double the rate (maximum 500 dispensers/ha) around borders of treatment area.
- Place dispensers on lateral branches at chest height within the canopy.
- Apply before adult borer emergence begins (typically end of May).

For lesser peach tree borer and peach tree borer:

- Place dispensers on lateral branches in mid-point of tree canopy.
- Apply before adult borer emergence begins (typically at or before shuck split).
- Dispensers are designed to last for the entire season.

Organic and Biopesticide Products for Disease Control

***Aureobasidium pullulans* (Blossom Protect)**

Blossom Protect is a biopesticide registered for the control of fire blight. Live strains of the yeasts *Aureobasidium pullulans* and a citric acid buffer are mixed together prior to application. The citric acid buffer lowers the pH in the blossoms which inhibits the growth and multiplication of the fire blight bacteria when they enter the blossoms. The lower pH also allows the yeast strains to colonize the same areas of the blossoms, blocking the infection site and utilizing the same nutrients as the fire blight bacteria.

Blossom Protect can be applied up to 5 times per season. If available, use a forecast system (e.g., Cougar Blight or MaryBlyt) to target the sprays 1–2 days before infection. If no forecast system is available, apply at 10, 40, 70 and 90% open blossoms. The yeast must colonize open blossoms before fire blight bacteria infect the blossom, so early application is important.

Apple varieties such as Elstar, Golden Delicious, Idared, Jonagold, Sansa, Santana, Braeburn and the pear variety Conference appear to be sensitive to enhanced russetting. Studies have shown that applications after petal fall will also result in enhanced russetting, particularly with the onset of fruit set, so this product should not be used to control fire blight in rattail blossoms.

***Bacillus subtilis* (Serenade MAX)**

Serenade MAX is registered for the suppression of a variety of diseases on fruit crops. Before using these products, consider whether suppression will be adequate in a commercial crop.

The active ingredient is *Bacillus subtilis*, which colonizes plant parts and helps prevent disease microorganisms from becoming established.

Crop-specific strategies

Apple – For suppression of fire blight, begin applications at early (1–5%) bloom at the beginning of a warming trend, and follow with a streptomycin spray 2 or 3 days later if warm temperatures continue to favour blossom infection. Serenade MAX should be used as part of an integrated fire blight suppression program, which includes a risk assessment model, as well as cultural controls and the use of streptomycin sprays when necessary. Serenade is also registered for suppression of powdery mildew and scab.

Berry crops – Serenade MAX provides suppression rather than control of botrytis grey mould and powdery mildew, when multiple applications are made before disease symptoms appear. Expect best control when Serenade MAX is used in rotation with other more effective products. Large ranges in rates are labelled for berry crops, with little information on when to use high or low rates. When using Serenade MAX, always leave an untreated area to evaluate the efficacy of this product.

Grape – Serenade MAX provides protection from botrytis bunch rot but has no post-infection activity. It also provides suppression of powdery mildew.

Citric acid + lactic acid (Tivano)

Tivano is registered for suppression of downy mildew on grapes and angular leaf spot and powdery mildew on strawberries. The active ingredients, citric and lactic acids, are the fermentation products of a particular strain of the bacteria *Lactobacillus casei*. They work by causing the plant pathogen's cell membranes to tear from the cell wall, due to water loss, thus killing the cell. This product also creates a physical barrier on the leaf surface, inhibiting infection spread.

This is a new product in Ontario and little evidence of its efficacy is available. Test on a small scale before using it more broadly.

Crop-specific strategies

Strawberry – Use for day-neutral strawberries. Multiple applications at 7–10-day intervals are required for maximum suppression. Apply in 200 L water/ha.

Grape – Use the higher rate and shorter application intervals with moderate to high disease pressure. Multiple applications at 7–10-day intervals are required for suppression. Apply in 200 L water/ha.

Copper (Copper 53W, Guardsman Copper Oxychloride 50, Copper Spray, Kocide 2000)

Copper works by destroying plant pathogen enzymes which are required for cell function. Spraying these products leaves a suspension of copper particles on the plant surface that forms a chemical barrier to protect plants from invasion. They do not affect pathogens that have already entered the plant tissue. It is important to use only copper products approved as crop protection products for application on agricultural crops that have a federal label with a Pest Control Product (PCP) number. For a summary of available products and crop uses, consult Table 9-2. *Copper Products Used on Fruit Crops*, page 254.

Free copper ions provide most of the activity copper mixtures have on fungal and bacterial diseases. However, free copper can also be toxic to plants, as it can cause burned leaves and russeted or scarred fruit, especially when spray solutions dry slowly.

Fixed copper collectively describes a group of copper formulations that contain complex copper sulphates (Copper 53 W), copper oxychlorides (Guardsman Copper Oxychloride 50, Copper Spray) and copper hydroxides (Kocide 2000).

These copper formulations have a small particle size and have added materials to improve spreading and sticking qualities. Always check the product label for use patterns, rates and timings for each crop.

Procedures to tank-mix copper formulations and lime

Some fixed copper labels suggest mixing the copper with lime. If problems occur while mixing fixed coppers with lime, follow these instructions:

1. Start water flow into the spray tank.
2. When the tank is about one-third full and the mechanical agitator is on, wash the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper, which form if opened product gets wet then dries, from getting into the tank. Premix the copper product with hot water to help the product dissolve. Put all of the copper in the tank by the time the tank is two-thirds full.
3. Wash the lime mixture through the screen into the copper solution in the tank. Use hydrated or builder's lime. Pre-soaking the lime before you add it to the copper solution in the tank may be preferable to washing powdered lime directly through the screen into the tank. Use a lot of water from the supply hose to dilute the lime as much as possible before it meets the copper solution.
4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

Table 9-2. Copper Products Used on Fruit Crops

Registered Copper Products	Rate of Formulated Copper ¹	Rate of Hydrated Lime ²
Apples		
Copper 53 W	1 kg	6 kg
Copper Spray	4 kg	no lime required
Blueberries (Highbush)		
Guardsman Copper Oxychloride 50	2–4 kg ³	no lime required
Copper Spray	2–4 kg ³	no lime required
Currants		
Copper 53 W	3–5 kg	4 kg
Filberts, Hazelnuts		
Guardsman Copper Oxychloride 50	3–9 kg/ha	no lime required
Copper Spray	3–9 kg/ha	no lime required
Gooseberries		
Copper 53 W	3–5 kg	4 kg
Grapes		
Copper 53 W ⁴	3 kg	6 kg
Guardsman Copper Oxychloride 50 ⁵	3 kg	6 kg
Copper Spray ⁵	3 kg	6 kg
Kocide 2000	1.6 kg/ha ⁶	454–1,360 g lime per 454 g Kocide ⁷
Nectarines		
Copper 53 W	4 kg	no lime required
Peaches		
Copper 53 W	1.9 kg	no lime required
Guardsman Copper Oxychloride 50	2 kg	no lime required
Copper Spray	2 kg	no lime required
Pears		
Copper 53 W	1 kg	6 kg

¹ Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.

² Rate is expressed kg/ha unless otherwise stated.

³ Rate is expressed in kg/500–1,000 L of water/ha.

⁴ Do not use on French hybrids or vinifera varieties.

⁵ Do not use on Seibel varieties.

⁶ Rate is expressed in kg/500–1,400 L water/ha. Foliage injury may occur on copper-sensitive varieties such as Concord, Delaware, Niagara and Rosette. Always test for sensitivity.

⁷ Addition of hydrated lime at this rate may reduce phytotoxicity.

⁸ Use 2 kg/ha with 4 kg/ha of hydrated lime for brown rot and leaf spot control. Use 6–9 kg/ha without lime for bacterial canker control.

Table 9-2. Copper Products Used on Fruit Crops (cont'd)

Registered Copper Products	Rate of Formulated Copper ¹	Rate of Hydrated Lime ²
Raspberries		
Copper 53 W	4–5 kg/ha	no lime required
Guardsman Copper Oxychloride 50	2.5–3.0 kg/ha	no lime required
Copper Spray	2.5–3.0 kg/ha	no lime required
Sour cherries		
Copper 53 W	2 kg	4 kg
Guardsman Copper Oxychloride 50	2 kg ⁶	4 kg
Copper Spray	2 kg ⁸	4 kg
Strawberries		
Copper 53 W	2.5–3.8 kg/ha	no lime required
Sweet cherries		
Guardsman Copper Oxychloride 50	6–9 kg/ha	no lime required
Copper Spray	6–9 kg/ha	no lime required
Walnuts		
Copper Spray	4 kg/ha	no lime required

¹ Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.

² Rate is expressed kg/ha unless otherwise stated.

³ Rate is expressed in kg/500–1,000 L of water/ha.

⁴ Do not use on French hybrids or vinifera varieties.

⁵ Do not use on Seibel varieties.

⁶ Rate is expressed in kg/500–1,400 L water/ha. Foliage injury may occur on copper-sensitive varieties such as Concord, Delaware, Niagara and Rosette. Always test for sensitivity.

⁷ Addition of hydrated lime at this rate may reduce phytotoxicity.

⁸ Use 2 kg/ha with 4 kg/ha of hydrated lime for brown rot and leaf spot control. Use 6–9 kg/ha without lime for bacterial canker control.

Garlic powder (Buran)

Buran is a biopesticide registered for the suppression of certain fungal pathogens. The active ingredient works by inhibiting germination of fungal spores on plant surfaces, and by interfering with the growth of the fungal mycelium. This product provides suppression only, and should be used in rotation with other fungicides. This is a new product in Ontario and little evidence of its efficacy is available.

Mineral oil (Purespray Green Spray Oil 13E)

As a fungicide, mineral oil acts as both an eradicant and a protectant, providing the destruction of lightly established infections and providing modest protection for a short period of time. It is susceptible to wash-off and activity is significantly reduced by as little as 5 mm of rain. It provides an alternative mode of action in a disease control program, reducing the likelihood of resistance to fungicides with specific modes of action.

Oriental mustard seed meal (MustGrow)

MustGrow is a biofumigant, registered for suppression of certain nematodes and soil-borne diseases. The active ingredient is derived from a particular variety of oriental

mustard, which contains high levels of glucosinolates, that is formulated as pellets. Enzymes convert glucosinolates to allyl isothiocyanate (AITC), which has activity on the labelled pests similar to conventional fumigants. These enzymes are activated by moisture in the soil after application.

Pantoea agglomerans (Bloomtime Biological FD)

Bloomtime is registered for suppression of fire blight. It is based on a strain of the non-pathogenic bacteria, *Pantoea agglomerans*, which colonizes the same areas of blossoms as the fire blight bacteria, but without causing any damage or plant disease. Once present, it competes with the fire blight bacterium for nutrients, keeping the number of harmful bacteria low. This product is preventative rather than curative – its efficacy depends on being applied and allowed to colonize plant surfaces before infection by the fire blight bacteria.

This product only suppresses fire blight, providing approximately 60% control without additional measures, and should be part of an integrated fire blight management program that includes monitoring, use of a risk assessment model, cultural controls and chemical

sprays. Suppression of the fire blight bacteria can still be very beneficial. Lower numbers of colonizing fire blight bacteria will result in more effective and fewer streptomycin applications in some orchards. Fewer applications of streptomycin can help reduce the risk of development of streptomycin-resistant fire blight bacteria.

Potassium bicarbonate (MilStop, Sirocco)

Potassium bicarbonate is a biochemical pesticide registered for suppression or control of powdery mildew. The active ingredient, potassium bicarbonate, is a colourless, odourless powder. It acts as a contact fungicide that kills the powdery mildew fungus by pulling water from its spores and cell walls. It also alters the pH on the leaf surface, which inhibits enzymes needed for formation of fungal cell walls, providing the plant with residual protection.

***Pseudomonas syringae* (Bio-Save 10 LP)**

The active ingredient in Bio-Save, *Pseudomonas syringae*, is a naturally occurring bacterium that is normally present on the surface of produce. Bio-Save is a biopesticide registered for post-harvest suppression of blue mould and botrytis grey mould on cherries, apples and pears, and for the suppression of mucor rot on apples and pears. The Bio-Save bacterium enters wounds on fruit where pathogen spores live and competes with plant pathogens for nutrients. At produce storage temperatures, it can outgrow the pathogens.

***Reynoutria sachalinensis* extract (Regalia Maxx)**

The active ingredient of Regalia Maxx is an extract of the giant knotweed plant that triggers the natural defense mechanisms of plants, inhibiting the development of certain plant pathogens. Regalia Maxx is a biopesticide labelled for the suppression rather than control of certain fungal diseases on grapes and strawberries, and works best when applied prior to the development of disease symptoms.

Crop-specific strategies

Berry crops – This is a new product in Ontario and little evidence of its efficacy is available.

Grape – Do not use as a solo product for powdery mildew from prebloom through berries pea-sized growth stage. Use 0.125% in a tank mix or rotation with other powdery mildew fungicides.

***Streptomyces lydicus* (Actinovate SP)**

Actinovate is a microbial pesticide registered for suppression of botrytis fruit rot and powdery mildew and reduction in symptoms of anthracnose fruit rot. Before using this product, consider whether suppression, or reduction in damage, will be adequate in a commercial crop.

The active ingredients are spores of *Streptomyces lydicus*, a naturally occurring bacterium commonly found in soil. Researchers think that this bacterium helps protect plants by growing over the plant surface, parasitizing fungal pathogens and producing antibiotics that are detrimental to these fungal diseases. When using Actinovate, always leave an untreated plot to evaluate the efficacy of this product. This is a new product in Ontario and little evidence of its efficacy is available.

Sulphur (Kumulus DF, Microscopic Sulphur, Microscopic Wetttable Sulphur, Microthiol Disperss, Lime Sulphur)

Sulphur products are not biopesticides, but some formulations may be organically acceptable. The active ingredients are elemental sulphur (obtained from rocks, underground deposits and other sources) or, in the case of lime sulphur, calcium polysulphide (obtained by combining elemental sulphur and calcium hydroxide). Sulphur inhibits spore germination and mycelial growth of plant pathogens. Sulphur can also have some secondary suppression or control activity against certain arthropods, and some products also list certain species of mite or scale on their label. Sulphur products can be phytotoxic under certain conditions.

10. Managing Pest Resistance

Pest Resistance to Fungicides, Insecticides and Miticides

Random natural mutation may result in a small proportion of a population that is resistant to a particular chemical or group of chemicals. When a population is exposed to a pesticide, the resistant individuals survive and the susceptible individuals are killed. The resistant survivors then multiply and pass their resistant traits on to the next generation. When the same pesticide is applied again, the proportion of resistant individuals increases, replacing the susceptible ones in the population. Once the resistant population dominates, the pesticide has lost efficacy. A pest population is considered resistant when it is able to survive exposure to rates of a pesticide that previously controlled it.

Resistance to one pesticide can result in resistance to other pesticides within a group or from a different one, especially pesticides with similar action sites. This is called **cross-resistance**. It develops when exposure to one pesticide causes selection for resistance in others.

Multiple resistance occurs when a pest is resistant to pesticides from different groups or sites of action at the same time.

Multiple resistance and cross-resistance create serious challenges to the success of integrated resistance management strategies.

Pest control failures are not necessarily caused by resistance. Factors such as product selection and timing, rate, spray coverage, spray water pH and weather conditions also affect the success or failure of a pesticide application.

Assessing resistance risk

The development of resistance depends on characteristics of both the pest and the group of pesticides involved, as well as the way in which pesticides are used. Table 10-1. *Factors Favouring the Development of Resistance* on this page describes situations where resistance is most likely to occur.

Resistance can develop very quickly for some pesticides. If a product is prone to resistance, do not use the product repeatedly unless it is used in rotation or combination with products from a different group.

Resistance Management Strategies

Resistance management strategies include rotating products from different groups and limiting the total number of applications from a single group within a growing season. Specific knowledge is required for growers to manage resistance effectively.

General resistance management strategies

- Follow an integrated pest management program that makes use of a variety of different pest control strategies, including monitoring, crop rotation, and biological and chemical control options.
- Spray only when necessary. Use established thresholds where available.
- Spray at the best timing for the pest and the product you are using.
- Make each spray application count. Be sure the sprayer is calibrated, the correct rate is applied and spray coverage is complete.
- Read the product label. New products include resistance management recommendations on the label.

Table 10-1. Factors Favouring the Development of Resistance

Pests most likely to develop resistance	Pesticides or use patterns where resistance is likely to develop
• have a prolific life cycle, with many generations per year, produce lots of spores, or multiply very quickly • have a pre-existing resistance to other products in the same group • have a narrow host range, spending entire life cycle on one crop • do not migrate between crops/regions, so gene pool is not diluted	• are used repeatedly or have persistent residues, exposing many generations to residues • are toxic to beneficial insects as well as the pest • have a specific mode of action that works on a single site • are used at deficient rates or improper times

- Know the active ingredient of a pesticide. Many chemicals with the same active ingredients are marketed under different brand names. For example, the insecticide permethrin is marketed under the brand names Pounce and Perm-Up.
- Know the group. Choose products from different groups when possible in your spray rotation. For example, both Assail and Admire are in the same insecticide group. To use Assail after Admire is equivalent to using Assail after Assail, since resistance to both chemicals develops at the same time. This can happen even if only one has been used repeatedly.

For a list of groups and their modes of action, see Table 10-2. *Fungicide/Bactericide Groups*, page 260 and Table 10-3. *Insecticide/Miticide Groups*, page 264.

In addition to these general resistance management strategies for all products, more specific strategies have been developed for fungicides, insecticides and miticides.

Managing resistance to fungicides

- Know the fungicide groups. Over a season, choose fungicides from different groups whenever possible.
- Limit the total number of applications, and the number of sequential applications, of a particular fungicide group per season. Newer fungicides will have specific resistance management strategies on the product label.
- Know which disease is targeted by which fungicide group. For combination products, know which fungicide component is controlling which disease. For example, Pristine is a combination of boscalid (Group 7) and pyraclostrobin (Group 11). Boscalid is strong against botrytis grey mould, and pyraclostrobin is effective against powdery mildew and anthracnose. Alternating Pristine with other fungicides in Group 7 is not effective for resistance management of botrytis.
- Apply fungicides before disease occurs. Applications of fungicides after the disease is established are more likely to select for resistant populations of the pathogen.
- Make use of Group M fungicides. These fungicides are known as multi-site inhibitors (Table 10-2. *Fungicide/Bactericide Groups*, page 260). They affect a wide range of metabolic processes in fungi and are not prone to the development of resistance. These products can be applied to fungal pathogens repeatedly, without rotation, with no significant risk of resistance development. Coppers are exceptions to this with respect to bacteria. For example, bacteria causing fire blight or blister spot can develop resistance to these products.

- Tank-mix products from different groups. Wherever possible, one of the tank-mix partners should be a fungicide from Group M, with a multi-site mode of action. (This is an accepted resistance management strategy for fungicides, although not recommended for insecticides.)

Resistance management strategies by fungicide group and disease for Ontario fruit crops

Resistance management strategies are important for diseases like botrytis, powdery mildew, downy mildew, brown rot and apple scab because these pathogens have characteristics which favour the development of resistance (see Table 10-1. *Factors Favouring the Development of Resistance*, page 257).

The suggested strategies for preventing fungicide resistance were developed using the recommendations of the Fungicide Resistance Action Committee (FRAC), which is a working group of Crop Life International. They were then adapted specifically for Ontario based on:

- the resistance risk of the pathogen to a particular fungicide group
- the number of rotation options registered for use at this time

Two components of a resistance management strategy for a fungicide group include the number of consecutive applications before rotating to a different group and the maximum number of applications per season. These strategies reduce the risk for resistance development, and may be more stringent than label guidelines.

- For high-risk pathogens with fungicide options from many groups, rotation to a different group is advisable after a single application of a resistance-prone fungicide, although this is not necessarily required by the label.
- For pathogens controlled by only a few registered fungicide groups, use no more than 2 consecutive applications of a resistance-prone fungicide and then alternate to a different fungicide group.

When a product contains active ingredients from more than one group, each application counts as a use for each group.

In some cases, a single fungicide group can control more than one pathogen. In this case, the maximum number of consecutive and total applications per season should be based on the pathogen with the highest risk of developing resistance.

Solo products have one active ingredient. Combination products have more than one active ingredient and are indicated with an asterisk (*).

Group 3: Funginex, Indar, Inspire, Inspire Super*, Jade, Mettle, Mission, Nova, Nustar, Proline, Topas, Quash

Apple scab resistance to Nova and Nustar has recently been confirmed in Ontario. Avoid using these products in orchards with resistance.

- **Apple** – For apple scab, use no more than 2 consecutive applications then rotate to a different fungicide group. Use fungicides from this group no more than 4 times per season as a solo or mixture product.
- **Berry crops** – For powdery mildew, use no more than 2 consecutive applications then rotate to a different fungicide group. Use fungicides from this group no more than 4 times per season.
- **Grape** – For powdery mildew, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season.
- **Stone fruit** – For brown rot, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season.

Group 7: Cantus, Fontelis, Luna Tranquility*, Pristine*

- **Apple** – Avoid using Pristine in apple orchards with documented resistance to Group 11 fungicides.
- **Berry crops** – For botrytis grey mould, use no more than 2 consecutive applications then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo or mixture product from this group. See Group 11 for recommendations for Pristine use.
- **Grape** – For powdery mildew, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season as a solo or mixture product.
- **Stone fruit** – For brown rot, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season as a solo or mixture product.

Group 9: Inspire Super*, Luna Tranquility*, Scala, Switch*, Vanguard

- **Apple and pear** – For scab, use once then rotate to a different fungicide group. Use fungicides from this group prebloom only and no more than 2 times per season.

- **Berry crops** – For botrytis grey mould, use once then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo or mixture product from this group.

- **Grape** – For botrytis bunch rot, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season.

- **Stone fruit** – For brown rot, use once then rotate to a different fungicide group. Use solo fungicides (Scala, Vanguard) from this group no more than 2 times per season and co-formulations (Inspire Super, Luna Tranquility, Switch) no more than 3 times per season.

Group 11: Cabrio, Flint, Pristine*, Quadris, Sovran, Tanos*

Apple scab resistance to Flint and Sovran has recently been confirmed in Ontario. Avoid using these products in orchards with resistance.

- **Apple and pear** – For scab, use no more than 2 consecutive applications then rotate to a different fungicide group. Use fungicides from this group no more than 3 times per season as a solo or mixture product.
- **Berry crops** – For botrytis grey mould, use no more than 2 consecutive applications then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo product from this group or no more than 50% of total fungicides applied per season if using combination products.
- **Grape** – For powdery mildew, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season as a solo or mixture product.
- **Stone fruit** – For brown rot, use once then rotate to a different fungicide group. Use fungicides from this group no more than 2 times per season as a solo or mixture product.

Group 12: Scholar, Switch*

- **Apple and pear** – For storage rots, do not make more than 1 postharvest application of Scholar.
- **Berry crops** – For botrytis grey mould, use no more than 2 consecutive applications of Switch then rotate to a different fungicide group. No more than 50% of total fungicides applied per season should include a product from this group.

Group 13: Quintec

- **Strawberry** – For powdery mildew, use no more than 2 consecutive applications then rotate to a different fungicide group. No more than 50% of total fungicides applied per season should include a product from this group.
- **Grape** – For powdery mildew, use once then rotate to a different fungicide group. Use no more than 2 times per season.
- **Stone fruit** – For powdery mildew, use once then rotate to a different fungicide group. Use no more than 2 times per season.

Group 17: Elevate

- **Berry crops** – For botrytis grey mould, use no more than 2 consecutive applications then rotate to a different fungicide group. Use no more than 4 times per season.
- **Grape** – For botrytis bunch rot, use once then rotate to a different fungicide group. Use no more than 2 times per season.
- **Stone fruit** – For brown rot, use once then rotate to a different fungicide group. Use no more than 2 times per season.

Group 33: Aliette, Confine Extra, Phostrol, Rampart

- **Grape** – For downy mildew, use once then rotate to a different fungicide group. Use fungicides from this group no more than 3 times per season.

Group 40: Acrobat, Revus, Zampro*

- **Grape** – For downy mildew, use once then rotate to a different fungicide group. Use Revus or Acrobat no more than 2 times per season and Zampro no more than 3 times per season.

Group 43: Presidio

- **Grape** – For downy mildew, tank-mix with a labelled rate of another fungicide registered for this disease, but with a different mode of action. Use once then rotate to a different fungicide group. Use no more than 2 times per season.

Group 45: Zampro*

- **Grape** – For downy mildew, use once then rotate to a different fungicide group. Use no more than 3 times per season.

Group U8: Vivando

- **Grape** – For powdery mildew, use once then rotate to a different fungicide group. Use no more than 2 times per season.

Table 10-2. Fungicide/Bactericide Groups

Group	Chemical Group	Product Name	Active Ingredient*
1	MBC (methyl benzimidazole carbamates)	Mertect SC Senator 70 WP	thiabendazole thiophanate-methyl
2	Dicarboximides	Rovral	iprodione
3	DMI (demethylation inhibitors) Note: sometimes loosely known as sterol inhibitors (SI)	Funginex DC Indar Inspire Inspire Super Jade Mettle 125 ME Mission 418 EC Nova 40 W Nustar Proline 480 SC Quash Topas	triforine fenbuconazole difenoconazole difenoconazole* + cyprodinil propiconazole tetraconazole propiconazole myclobutanil flusilazole prothioconazole metconazole propiconazole

M = Multi-site fungicides. NC = Not classified by FRAC, or group not indicated on product label. P = Plant extract. U = Mode of action has not been determined.

* Indicates the active ingredient (a.i.) that puts it in this group.

** Recently renamed, formerly Group 18.

Table 10-2. Fungicide/Bactericide Groups (cont'd)

Group	Chemical Group	Product Name	Active Ingredient*
4	PA (phenylamides)	Ridomil Gold MZ 68WG Ridomil Gold 480 SL	metalaxyl* + mancozeb metalaxyl
7	SDHI (succinate dehydrogenase inhibitors)	Cantus WDG Fontelis Luna Tranquility Pristine WG	boscalid penthiopyrad fluopyram* + pyrimethanil boscalid* + pyraclostrobin
9	AP (anilinopyrimidines)	Inspire Super Luna Tranquility Scala SC Switch 62.5 WG Vanguard 75 WG	difenoconazole + cyprodinil* fluopyram + pyrimethanil* pyrimethanil cyprodinil* + fludioxonil cyprodinil
11	QoI (quinone outside inhibitors) Note: strobilurins belong in this group, but not all QoI are strobilurins	Cabrio EG Flint Pristine WG Quadris Sovran Tanos 50 DF	pyraclostrobin trifloxystrobin boscalid + pyraclostrobin* azoxystrobin kresoxim-methyl cymoxanil + famoxadone*
12	PP (phenylpyrroles)	Scholar 230 SC Switch 62.5 WG	fludioxonil cyprodinil + fludioxonil*
13	Aza naphthalenes	Quintec	quinoxifen
17	Hydroxyanilide	Elevate 50 WDG	fenhexamid
22	B3 Benzamide	Gavel 75 DF	mancozeb + zoxamide*
24	Antibiotic	Kasumin 2L	kasugamycin
25**	Antibiotic	Streptomycin 17	streptomycin
27	Cyanoacetamide oxime	Tanos 50 DF	cymoxanil* + famoxadone
29	2,6-dinitroaniline	Allegro 500 F	fluzinam
33	Phosphonate	Aliette Confine Extra Phostrol Rampart	fosetyl al mono- and dipotassium salts of phosphorous acid mono- and dibasic sodium, potassium and ammonium phosphites mono- and dipotassium salts of phosphorous acid
40	CAA (carboxylic acid amides)	Acrobat 50 WP Revus Zampro	dimethomorph mandipropamid dimethomorph* + ametoctradin
43	B5 Benzamide	Presidio	fluopicolide
44	Microbial	Serenade Max	<i>Bacillus subtilis</i> strain QST 713
45	QxI (quinone x inhibitor)	Zampro	dimethomorph + ametoctradin*
M1	Inorganic	Copper 53 W Copper Spray Guardsman Copper Oxychloride Kocide 2000	tri-basic copper sulphate copper oxychloride copper oxychloride copper hydroxide

MI = Multi-site fungicides. NC = Not classified by FRAC, or group not indicated on product label. P = Plant extract. U = Mode of action has not been determined.

* Indicates the active ingredient (a.i.) that puts it in this group.

** Recently renamed, formerly Group 18.

Table 10-2. Fungicide/Bactericide Groups (cont'd)

Group	Chemical Group	Product Name	Active Ingredient*
M2	Inorganic	Kumulus DF	sulphur
		Lime Sulphur	lime sulphur
		Microscopic Sulphur	sulphur
		Microthiol Disperss	sulphur
M3	Dithiocarbamate	Dithane DG	mancozeb
		Ferbam WDG	ferbam
		Gavel 75 DF	mancozeb* + zoxamide
		Granuflo T	thiram
		Manzate Pro-Stick	mancozeb
		Penncozeb 75 DF Raincoat	mancozeb
		Polyram DF	metiram
		Ridomil Gold MZ 68WG	metalaxyl + mancozeb*
		Thiram 75 WP	thiram
M4	Phthalimide	Folpan 80 WDG	folpet
		Maestro 80 DF	captan
		Supra Captan 80 WDG	captan
M5	Chloronitrile	Bravo 500	chlorothalonil
		Echo 720	chlorothalonil
NC	Biological	Actinovate SP	<i>Streptomyces lydicus</i>
		Bio-Save 10 LP	<i>Pseudomonas syringae</i>
		Bloomtime Biological FD	<i>Pantoea agglomerans</i>
		Blossom Protect	<i>Aureobasidium pullulans</i>
NC	Bicarbonate	MilStop	potassium bicarbonate
		Sirocco	potassium bicarbonate
NC	Oil	Purespray Green Spray Oil 13E	mineral oil
NC	Not classified	Tivano	citric acid + lactic acid
NC	Not classified	Buran	garlic powder
P5	Plant extract	Regalia Maxx	<i>Reynoutria sachalinensis</i> extract
U8	Benzophenone	Vivando	metrafenone
U12	Guanidines	Equal 65 WP	dodine
		Syllit 400 FL	dodine

M = Multi-site fungicides. NC = Not classified by FRAC, or group not indicated on product label. P = Plant extract. U = Mode of action has not been determined.

* Indicates the active ingredient (a.i.) that puts it in this group.

** Recently renamed, formerly Group 18.

Managing resistance to insecticides and miticides

- Know the insecticide groups. Rotate products from different groups. Avoid sequential applications of the same group or repeated use of any insecticide or group of insecticides.
- For insects with discrete generations (e.g., oriental fruit moth, codling moth, grape berry moth), manage each generation of an insect pest as separate units. Use products from a single insecticide group to manage a given generation of a pest. If the pest emergence or

activity for that generation is prolonged, apply a second application of the same product. This exposes each generation to only one group. Rotate to another insecticide group (or groups) for subsequent generations. If re-treatments are necessary for a particular generation, choose a product in that same group.

- For pests whose populations build quickly and with multiple, overlapping generations (e.g., aphids, mites), rotate between products in different insecticide groups for each spray.

- Avoid unnecessary or repeated applications of miticides and rotate between products in different groups. Many labels limit the number of applications of a product to one per season. Consider a multi-year rotation of miticides, so that mites are not exposed to products with a similar mode of action more frequently than once every 3–4 years.
- Consider annual delayed dormant oil or summer oils to suppress mite or aphid populations and reduce the need for miticides when numbers exceed the treatment threshold(s).
- Time sprays to contact the most susceptible life stage of the pest.
- Avoid tank-mixing different insecticides to manage a single pest, because this increases the probability that the target pest population will develop multiple resistance. Alternating products, rather than tank-mixing them, is the preferred strategy for insecticides and miticides.
- Consider area-wide resistance management programs such as mating disruption, especially for pests of more than one crop.

Resistance management strategies by insecticide group for Ontario fruit crops

Solo products have one active ingredient. Combination products have more than one active ingredient and are indicated with an asterisk (*).

Group 1A, 1B & 2A

Resistance to these older, broad-spectrum insecticides has occurred in various fruit pest populations in Ontario. Documented cases include resistance to organophosphates in spotted tentiform leafminer and codling moth on apples, obliquebanded leafroller on apples and pears, pear psylla on pears, and oriental fruit moth on peaches, nectarines, pears and apples.

Group 3: Ambush, Concept*, Decis, Matador, Perm-Up, Pounce, Pyganic, Ripcord, Silencer, Up-Cyte, Warrior

Present status of spotted tentiform leafminer and pear psylla resistance is unknown given that resistance in these pests has not been monitored since the early 1990s. Previous studies demonstrate that spotted tentiform leafminer adults became resistant to all pyrethroids in many orchards in Ontario when exposed to repeated applications of these chemicals. Pear psylla resistance to pyrethroids has been documented in western North America and some pear orchards in

the Niagara peninsula. Resistance may occur in other parts of the province. Documented cases of resistance in populations of obliquebanded leafroller on apples have been found.

The repeated use of pyrethroid insecticides (more than once per season) is discouraged because of the potential for further resistance development and because pyrethroids are toxic to beneficial insects and mites.

Group 4: Actara, Admire, Alias, Calypso, Closer, Clutch, Concept*

Documented cases of resistance to Calypso have been found in some codling moth populations in Ontario and Quebec.

Group 5: Delegate, Entrust, GF-120, Success

Resistance in western flower thrips to this group is known in greenhouse crops and could also be present in outdoor crops.

Group 11: Bioprotec, Dipel, Foray

There are no documented cases of resistance in Ontario for fruit crops. Use the basic principles of resistance management to ensure that insecticides in these groups work well in the future.

Group 15: Rimon

There are no documented cases of resistance in Ontario for fruit crops. Use the basic principles of resistance management to ensure that insecticides in these groups work well in the future.

Group 18: Confirm, Intrepid

Documented cross-resistance between organophosphate insecticides and the growth regulators, Confirm and Intrepid, has been found in some obliquebanded leafroller and codling moth populations, respectively, in Ontario. Where resistance is suspected for obliquebanded leafroller or codling moth, do not use Group 18, 1A or 1B. Always use one group of insecticides within the generation and rotate insecticide groups between generations. Consult the apple calendar for the appropriate timing of these products.

Group 28: Altacor, Exirel

There are no documented cases of resistance in Ontario for fruit crops. Use the basic principles of resistance management to ensure that insecticides in these groups work well in the future.

Table 10-3. Insecticide/Miticide Groups

Group	Type of Action	Chemical Sub-group or Exemplifying Active Ingredient	Product Name	Active Ingredient
1	Nerve	1A ¹ Carbamates	Lannate Toss-N-Go	methomyl
			Sevin XLR	carbaryl
			Vydate L	oxamyl
		1B ¹ Organophosphates	Cygon 480-AG	dimethoate
			Diazinon 50 WSP	diazinon
			Diazinon 500 E	diazinon
			Imidan 70-WP Instapak	phosmet
			Lagon 480 E	dimethoate
			Lorsban 50 W	chlorpyrifos
			Malathion 25 W	malathion
			Malathion 85 E	malathion
			Orthene 75% SP	acephate
			Pyrinex 480 EC	chlorpyrifos
			Warhawk 480 EC	chlorpyrifos
2	Nerve	2A ² Cyclodiene organochlorines	Thionex 50 WSP	endosulfan
3	Nerve	3A Pyrethroids Pyrethrins	Ambush 500 EC	permethrin
			Concept	imidacloprid + deltamethrin*
			Decis 5 EC	deltamethrin
			Matador 120 EC	lambda-cyhalothrin
			Perm-Up	permethrin
			Pounce 384 EC	permethrin
			Pyganic EC 1.4II	pyrethrins
			Ripcord	cypermethrin
			Silencer 120 EC	lambda-cyhalothrin
			Up-Cyte 2.5 EC	cypermethrin
			Warrior	lambda-cyhalothrin
4	Nerve	4A ¹ Neonicotinoids	Actara 25 WG	thiamethoxam
			Admire 240 F	imidacloprid
			Alias 240 SC	imidacloprid
			Assail 70 WP	acetamiprid
			Calypso 480 SC	thiacloprid
			Clutch 50 WDG	clothianidin
			Concept	imidacloprid* + deltamethrin
		4C ³ Sulfoxaflor	Closer SC	sulfoxaflor

NC = Not classified by IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

* Indicates the active ingredient (a.i.) that puts it in this group.

¹ All members of Group 1 may not be cross-resistant, although they share the same primary target site and mode of action. For this reason, Group 1 is divided into sub-groups Group 1A and 1B, each with different mechanisms of resistance. Assume that cross-resistance exists between pesticides in each sub-group, but that rotation of pesticides between sub-groups is an acceptable part of a resistance management program.

² Other resistance mechanisms that are not linked to site of action (i.e., enhanced metabolism) are common for this group of chemicals.

³ Although compounds in Groups 4A and 4C are thought to have the same target site, current evidence suggests the risk of metabolic cross-resistance between Groups 4A and 4C is low. If there are no other alternatives, then compounds from Groups 4A and 4C may be rotated.

Table 10-3. Insecticide/Miticide Groups (cont'd)

Group	Type of Action	Chemical Sub-group or Exemplifying Active Ingredient	Product Name	Active Ingredient
5	Nerve	Spinosyns	Delegate WG	spinetoram
			Entrust 80 W	spinosad
			Entrust SC	spinosad
			GF-120 Fruit Fly Bait	spinosad
			Success	spinosad
6	Nerve and muscle	Avermectins	Agri-Mek 1.9% EC	abamectin
9	Nerve-feeding blockers	9C Flonicamid	Beleaf 50 SG	flonicamid
10	Growth regulation	10A Clofentezine	Apollo SC	clofentezine
11	Disrupt midgut membrane	11A B.t. microbial (and the insecticidal proteins they produce)	Bioprotec CAF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
			Dipel 2X DF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
			Foray 48BA	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
15	Growth regulation	Benzoylureas	Rimon 10 EC	novaluron
18	Growth regulation	Diacylhydrazine	Confirm 240 F	tebufenozide
			Intrepid 240 F	methoxyfenozide
20	Energy metabolism	20B Acequinocyl	Kanemite 15 SC	acequinocyl
21	Energy metabolism	21A Mitochondrial complex I electron transport inhibitors (METI)	Nexter	pyridaben
23	Lipid synthesis, growth regulation	Tetronic and tetramic acid derivatives	Envidor 240 SC	spirodiclofen
			Movento 240 SC	spirotetramat
			Oberon	spiromesefin
28	Nerve and muscle	Diamides	Altacor	chlorantraniliprole
			Exirel	cyantraniliprole
NC	Unknown	Granulosis virus	CYD-X	<i>Cydia pomonella</i> granulovirus
			Virosoft	<i>Cydia pomonella</i> granulovirus
UN	Unknown	Bifenazate	Acramite 50 WS	bifenazate

NC = Not classified by IRAC, or group not indicated on product label. UN = Mode of action has not been determined.

* Indicates the active ingredient (a.i.) that puts it in this group.

¹ All members of Group 1 may not be cross-resistant, although they share the same primary target site and mode of action. For this reason, Group 1 is divided into sub-groups Group 1A and 1B, each with different mechanisms of resistance. Assume that cross-resistance exists between pesticides in each sub-group, but that rotation of pesticides between sub-groups is an acceptable part of a resistance management program.

² Other resistance mechanisms that are not linked to site of action (i.e., enhanced metabolism) are common for this group of chemicals.

³ Although compounds in Groups 4A and 4C are thought to have the same target site, current evidence suggests the risk of metabolic cross-resistance between Groups 4A and 4C is low. If there are no other alternatives, then compounds from Groups 4A and 4C may be rotated.

Resistance management strategies by miticide group for Ontario fruit crops

Group 6: Agri-Mek

There are no documented cases of resistant mite populations in Ontario to this group. Use resistance management principles. Apply this product early before threshold numbers are reached.

Group 10: Apollo

Isolated cases of mite resistance to Apollo have been found in Ontario. Resistance has occurred where Apollo has been applied repeatedly in one season, or applied too late in the season. To delay resistance to Apollo, do not use Apollo every year. Apply Apollo when the mite population is synchronous and in the first summer-generation egg stage.

Group 20B, 21 & 25: Kanemite, Nexter, Acramite

There are no documented cases of resistant mite populations in Ontario. Use resistance management principles.

Group 23: Envidor, Movento, Oberon

There are no documented cases of resistant mite populations in Ontario. Use resistance management principles. These products work slowly, so patient and careful monitoring is needed to assess the results.

11. Information on Pesticides

Efficacy Ratings for Pesticides

The value of all insecticides, miticides, and fungicides are evaluated by the Pest Management Regulatory Agency (PMRA) prior to registration, which includes an assessment of efficacy. Wording on the product label such as control, suppression, or partial suppression is used to describe the level of pest management provided by these products. The definitions of “control” and “suppression” for insecticides have a somewhat different meaning than the same terms applied to fungicides, as shown in Table 11-1. *Pesticide Efficacy Ratings* on this page.

For direct pests that cause damage to the fruit, it is important to choose products that provide control rather than suppression. However, if the pest is an

indirect pest, and does not affect fruit directly, products labelled for suppression may be useful. Together with natural enemies or biological control, products used for suppression might be enough to prevent significant crop damage. Products labelled for suppression may also play a role in resistance management. By alternating with products from different families, the risk of pest resistance to important products can be reduced.

Price and intended markets play a big part of the decision to use products for suppression. Sometimes there are no other options for organic pest management. However, when using a new product for pest suppression, try to leave an untreated check and evaluate the benefits of using these products compared to the cost of application.

Table 11-1. Pesticide Efficacy Ratings

Pesticide	Efficacy term	Defined as
Insecticide Miticide	Control	• The product, when applied in accordance with the label directions, consistently reduces pest numbers or pest damage to a commercially acceptable level.
	Suppression	• The product, when applied in accordance with the label directions, does not reduce pest populations or damage to a level typically required to achieve commercially acceptable control. Under such situations, the level of performance offered by the product should still have value in a pest management program.
Fungicide	Control	• A consistent level of disease management, as defined by commercial standards and expectations in the market, when compared to untreated control plots. In general, disease control ratings would be between 80–100%.
	Suppression	• A consistent level of disease management that is less than full control, as defined by commercial standards and expectations in the market, when compared to untreated control plots. In general, disease control ratings would be between 60–80%. • Suppression is defined as consistent disease reduction to a level that is not optimal but is still of commercial benefit.
	Partial suppression	• A level of disease management that is less than suppression, as defined by the commercial standards and expectations in the market. This label claim will generally only be considered for non-conventional fungicides. In general, disease control ratings would be less than 40%.

Source: Pest Management Regulatory Agency (PMRA), January 2014.

Relative Acute Toxicity of Pesticides

Acute toxicity is the toxic response that results from a single exposure to a pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity. Pesticides and plant growth regulators listed here are grouped according to the relative acute toxicity and warning symbol on the label. This list does not provide information on chronic toxicity, which is the toxic response that results from repeated exposures to small doses of a pesticide over a longer time period. Other warnings about specific hazards, such as corrosiveness and skin or eye irritations, are not included in this list, but can be found on the product label.

Danger Poison Symbol*

High acute toxicity

- Calypso 480 SC
- Chloropicrin 100
- Decis 5 EC
- Diazinon 500 E
- Diazinon 50 WSP
- Enfuse M 510
- Imidan 70-WP Instapak
- Lannate Toss-N-Go
- Lime Sulphur
- Lorsban 50 W
- Matador 120 EC
- Perm-Up
- Pic Plus Fumigant
- Pyrinex 480 EC
- Silencer 120 EC
- Superior 70 Oil
- Thionex 50 WSP
- Up-Cyde 2.5 EC
- Vydate L
- Warhawk 480 EC
- Warrior

Warning Poison Symbol*

Moderate acute toxicity

- Agri-Mek 1.9% EC
- Assail 70 WP
- Bartlett Waxed Mouse Bait
- Busan 1020
- Busan 1180
- Busan 1236
- Copper 53 W
- Copper Spray
- Cygon 480-AG
- Dithane DG
- Echo 720
- Folpan 80 WDG
- Guardsman Copper Oxychloride 50
- Lagon 480 E
- Malathion 85 E
- Manzate Pro-Stick
- Mission 418 EC
- Nexter
- Ramik Brown
- Ridomil Gold 480 SL
- Sevin XLR
- Tanos 50 DF
- Thiram 75 WP
- Zampro

Caution Poison Symbol*

Low acute toxicity

- Admire 240 F
- Alias 240 SC
- Allette
- Allegro 500 F
- Apollo SC
- Cantus WDG
- Elevate 50 WDG
- Envidor 240 SC
- Jade
- Kocide 2000
- Malathion 25 W
- Microscopic Sulphur
- Microthiol Disperss
- Nova 40 W
- Oberon
- Orthene 75% SP
- Pounce 384 EC
- Presidio
- Proline 480 SC
- Quash
- ReTain
- Ripcord
- Rovral WDG
- Scala SC
- Skoot
- Sovran
- Syllit 400 FL
- Topas
- Vangard 75 WG
- Vapam HL

No Poison Symbol*

Lower acute toxicity

- Acramite 50 WS
- Acrobat 50 WP
- Actara 25 WG
- Actinovate SP
- Altacor
- Ambush 500 EC
- Apogee
- Beleaf 50 SG
- Bioprotec CAF
- Bio-Save 10 LP
- Bloomtime Biological FD
- Blossom Protect
- Bravo 500
- Buran
- Cabrio EG
- Cilis Plus
- Closer SC
- Clutch 50 WDG
- Concept
- Confine Extra
- Confirm 240 F
- Cyd-X
- Delegate WG
- Dipel 2X DF
- Entrust 80 W
- Entrust SC
- Equal 65 WP
- Ethrel
- Exirel
- Falgro Tablet
- Ferbam 76 WDG
- Flint
- Fontelis
- Foray 48BA
- Fruitone N
- Funginex DC
- Gavel 75 DF
- GF-120 Fruit Fly Bait
- Granuflo T
- Indar
- Inspire
- Inspire Super
- Intrepid 240 F
- Isomate-CM/OFM TT
- Isomate-DWB
- Isomate-GBM Plus
- Isomate-M 100
- Isomate-M Rosso
- Isomate-PTB Dual
- Kanemite 15 SC
- Kasumin 2L
- Kumulus DF
- Luna Tranquility
- Maestro 80 DF
- Maxcel
- Mertect SC
- Mettle 125 ME
- MilStop
- Movento 240 SC
- MustGrow
- Opal
- Penncozeb 75 DF Raincoat
- Perlant
- Phostrol
- Polyram DF
- Pristine WG
- Promalin
- Purespray Green Spray Oil 13E
- Pyganic EC 1.4II
- Quadris
- Quintec
- Rampart
- Regalia Maxx
- Revus
- Ridomil Gold MZ 68 WG
- Rimol 10 EC
- Scholar 230 SC
- Senator 70 WP
- Serenade MAX
- Sirocco
- Sluggo Professional
- Streptomycin 17
- Success
- Supra Captan 80 WDG
- Surround WP
- Switch 62.5 WG
- Tivano
- Virosoft CP4
- Vivando SC

* See label for other important warnings including corrosiveness, skin and eye irritations and chronic toxicity.

Bee Poisoning

Honeybees, native bee species and other pollinating insects are important pollinators for many Ontario crops. Insecticides, some of which may negatively affect bees, require careful management to achieve both pollination and insect control. Growers and licensed commercial applicators can protect bees by following these suggestions:

- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Do not spray any flowering crop on which bees are foraging.
- Time insecticide applications to minimize bee poisoning. Daytime treatments, when bees are foraging, are most hazardous. Insecticide applications in the evening are the safest. Spraying after 8 pm allows the spray to dry before the bees are exposed to it the next day. This is the most successful way to avoid bee damage. Early morning is the next best time, but spraying should be completed before 7 am. While honeybees and most other pollinating insects do not usually forage at temperatures below 13°C, bumblebees do. If you plan to spray in the morning, contact beekeepers who have bees within 10 km of your crop. The beekeepers will then have the option of taking protective action.
- Beekeepers should remove honeybee colonies as soon as pollination is complete and before any insecticides are applied postbloom.
- If colonies cannot be removed before insecticides are applied, beekeepers can place wet burlap or cloth at the entrance of the hive to disrupt the flight of the bees for up to 12 hours and provide more time for spray to dry. An opening of 2.5 cm on each side of the hive entrance is necessary so the bees can get out and ventilate the hive.
- Bees and other pollinators may be poisoned by visiting flowering weeds (e.g., dandelions) or cover crops (e.g., clover) that have come in contact with an insecticide. Avoid spray drift to blooming plants that are adjacent to or within the target field. Where possible, mow down such crops prior to spraying to help safeguard the bees.
- To prevent drift toward nearby hives, do not apply insecticides on windy days or when there is evidence of a strong temperature inversion.
- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to bees. When there is a choice, choose a product formulation that is less hazardous to bees. See Table 11-2. *Relative Toxicity of Pesticides to Honeybees*, page 270.
- Before applying a pesticide, advise local beekeepers so they can move colonies out of the danger area, if this is an option. Contact information for the local beekeepers' association in your area can be found on the Ontario Beekeepers' Association website at www.ontariobee.com/community/local-beekeepers-associations. Other ways to find your local beekeepers are to contact the Provincial Apiarist at 1-888-466-2372, ext. 63595, or see www.ontario.ca/crops and click "Apiculture" and then "Bee Inspectors" for a list of provincial bee inspectors who know the local beekeepers.

For more detailed information on the toxicity of specific pesticides to honeybees, refer to the pesticide label.

Table 11-2. Relative Toxicity of Pesticides to Honeybees**Group I:****Pesticides highly toxic to bees**

Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter.

Trade or Brand Name	Common Name/ Active Ingredient
Actara 25 WG	thiamethoxam
Admire 240 F	imidacloprid
Agri-Mek 1.9% EC	abamectin
Alias 240 SC	imidacloprid
Ambush 500 EC	permethrin
Closer SC	sulfoxaflor
Clutch 50 WDG	clothianidin
Concept	imidacloprid + deltamethrin
Cygon 480-AG	dimethoate
Decis 5 EC	deltamethrin
Delegate WG	spinetoram
Diazinon 500 E	diazinon
Diazinon 50 WSP	diazinon
Entrust 80 W	spinosad
Entrust SC	spinosad
Exirel	cyantraniliprole
GF-120 Fruit Fly Bait	spinosad
Imidan 70-WP Instapak	phosmet
Lagon 480 E	dimethoate
Lannate Toss-N-Go	methomyl
Lorsban 50 W	chlorpyrifos
Malathion 25 W	malathion
Malathion 85 E	malathion
Matador 120 EC	lambda-cyhalothrin
Movento 240 SC	spirotetramat
MustGrow*	oriental mustard seed meal
Nexter	pyridaben
Orthene 75% SP	acephate
Perm-Up	permethrin
Pounce 384 EC	permethrin
Pyganic EC 1.4 II	pyrethrins
Pyrinex 480 EC	chlorpyrifos
Ripcord	cypermethrin
Sevin XLR	carbaryl
Silencer 120 EC	lambda-cyhalothrin
Success	spinosad
Up-Cycle 2.5 EC	cypermethrin
Vydate L	oxamyl
Warhawk 480 EC	chlorpyrifos
Warrior	lambda-cyhalothrin

* The active ingredient in MustGrow is considered highly toxic to bees although risk is low due to minimal exposure.

Group II:**Pesticides moderately toxic to bees**

These can be used around bees if dosage, timing, and method of application are correct, but do not apply them directly on bees, in the field or at the colonies.

Trade or Brand Name	Common Name/ Active Ingredient
Acramite 50 WS	bifenazate
Assail 70 WP	acetamiprid
Copper 53 W	tri-basic copper sulphate
Envidor 240 SC	spirodiclofen
Maestro 80 DF	captan
Quintec	quinoxifen
Rimon 10 EC**	novaluron
Supra Captan 80 WDG	captan
Thionex 50 WSP	endosulfan

**Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds.

Group III:**Pesticides relatively non-toxic to bees**

Trade or Brand Name	Common Name/ Active Ingredient
Acrobat 50 WP	dimethomorph
Actinovate SP	<i>Streptomyces lydicus</i>
Aliette	fosetyl al
Allegro 500 F	fluazinam
Altacor	chlorantraniliprole
Apogee	prohexadione calcium
Apollo SC	clofentezine
Beleaf 50 SG	flonicamid
Bioprotec CAF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Bloomtime Biological FD	<i>Pantoea agglomerans</i>
Blossom Protect	<i>Aureobasidium pullulans</i>
Bravo 500	chlorothalonil
Buran	garlic powder
Cabrio EG	pyraclostrobin
Calypso 480 SC	thiacloprid
Cantus WDG	boscalid
Confine Extra	mono- and di-potassium salts of phosphorous acid
Confirm 240 F	tebufenozide
Copper Spray	copper oxychloride
Cyd-X	<i>Cydia pomonella</i> granulovirus
Dipel 2X DF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Dithane DG	mancozeb
Echo 720	chlorothalonil
Elevate 50 WDG	fenhexamid
Equal 65 WP	dodine

Source: PMRA Environmental Assessment Division. For more detailed information on the toxicity of specific pesticides to honeybees, refer to the pesticide label.

Table 11-2. Relative Toxicity of Pesticides to Honeybees (cont'd)

Group III:

Pesticides relatively non-toxic to bees (cont'd)

Trade or Brand Name	Common Name/ Active Ingredient
Ferbam 76 WDG	ferbam
Flint	trifloxystrobin
Folpan 80 WDG	folpet
Fontelis	penthiopyrad
Foray 48BA	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Funginex DC	triforine
Gavel 75 DF	zoxamide + mancozeb
Granuflo-T	thiram
Indar	fenbuconazole
Inspire	difenoconazole
Inspire Super	difenoconazole + cyprodinil
Intrepid 240 F	methoxyfenozide
Jade	propiconazole
Kanemite 15 SC	acequinocyl
Kasumin 2L	kasugamycin
Kocide 2000	copper hydroxide
Kumulus DF	sulphur
Luna Tranquility	fluopyram + pyrimethanil
Manzate Pro-Stick	mancozeb
MaxCel	6-benzyladenine
Mettler 125 ME	tetraconazole
Microthiol Dispers	sulphur
MilStop	potassium bicarbonate
Mission 418 EC	propiconazole
Nova 40 W	myclobutanil
Oberon	spiromesifen
Opal	potassium salts of fatty acids
Penncozeb 75 DF Raincoat	mancozeb
Phostrol	mono- and di-basic sodium, potassium and ammonium phosphites
Polyram DF	metiram
Presidio	fluopicolide
Pristine WG	boscalid + pyraclostrobin
Proline 480 SC	prothioconazole
Quadrif	azoxystrobin
Quash	metconazole
Rampart	mono- and di-potassium salts of phosphorous acid
Regalia Maxx	<i>Reynoutria sachalinensis</i> extract
Revus	mandipropamid
Ridomil Gold 480 SL	metalaxyl-m and s-isomer
Ridomil Gold MZ 68 WG	metalaxyl-m and s-isomer + mancozeb
Rovral WDG	iprodione
Scala SC	pyrimethanil

Group III:

Pesticides relatively non-toxic to bees (cont'd)

Trade or Brand Name	Common Name/ Active Ingredient
Scholar 230 SC	fludioxonil
Senator 70 WP	thiophanate-methyl
Serenade MAX	<i>Bacillus subtilis</i>
Sirocco	potassium bicarbonate
Sovran	kresoxim-methyl
Switch 62.5 WG	cyprodinil + fludioxonil
Sylit 400 FL	dodine
Tanos 50 DF	famoxadone + cymoxanil
Thiram 75 WP	thiram
Tivano	citric acid + lactic acid
Topas	propiconazole
Vangard 75 WG	cyprodinil
Virosoft CP4	<i>Cydia pomonella</i> granulovirus
Vivando	metrafenone
Zampro	dimethomorph + ametoctradin

Source: PMRA Environmental Assessment Division. For more detailed information on the toxicity of specific pesticides to honeybees, refer to the pesticide label.

Handling and Mixing Pesticides

Formulations

Dry pesticide formulations include:

- **Wettable powders** – active ingredients added to a wetting and dispersion agent, such as talc mixed with water. They will not dissolve, but form a suspension that requires constant agitation. Unless the label states otherwise, premix wettable powders with water and add the slurry to the spray tank.
- **Granules** – a mix of dry, large free-flowing particles, usually with a low concentration of active ingredient. They are ready to be added directly to water.
- **Soluble powders** – dry materials, similar to granules, but dissolve in water.

Liquid pesticide formulations mix in water to form a solution. Some pesticides may be oil-based, such as emulsifiable concentrates, and form an opaque (milky) emulsion that requires agitation.

Soluble packaging

Water-soluble packaging is used for dry flowable and wettable powder formulations. In most cases, the water-soluble packaging material is PVA (polyvinyl alcohol), which dissolves completely when added to the tank water according to instructions. Read labels carefully.

- Keep soluble pouches dry until added to the spray tank.
- Do not handle pouches with wet hands or wet gloves.
- Do not remove pouches from the outer package until just before use.
- Always reseal the outer package to protect the remaining pouches from moisture.

Mixing soluble pouches

Consult product labels for specific mixing instructions for each product.

1. Half-fill the spray tank with water and have the agitator running. Add pouches to the tank.
2. Most pouches dissolve completely within 5 minutes, depending on water temperature and agitation.
3. As the tank continues to fill, add any other compatible pesticides.

Do not add:

- A pesticide that is incompatible with the PVA packaging material, such as oils (e.g., Superior Oil) and emulsifiable concentrate formulations containing mineral or vegetable oil.
- Any material containing boron, chelated micronutrients or water-soluble fertilizers. Rinse spray tank carefully after applying these nutrients.

Compatibility of spray materials

Users of commercial-class pest control products for crop protection or vegetation management are permitted to apply unlabelled tank mixes as long as:

- each product is registered for use in Canada on the crop.
- each product is used according to the label.
- the tank-mix only includes an adjuvant when specifically required by one of the product labels.
- the application timing of each product is compatible with crop and pest staging.
- no product is specifically excluded on any other of the tank-mix product labels.

For information on compatibility of spray materials, always check the product label. Physical incompatibility can result in a physical change in the solution. Components of the combined product may plug nozzles or become solidified or gummy in the tank. Chemical incompatibility can result in a chemical change in the solution. This can lead to reduced efficacy, or can cause plant injury when sprayed on the crop.

Generally, compatibility:

- varies with the formulation of the products. For example, two products may be compatible as wettable powder formulations, but the same active ingredient may be incompatible as emulsifiable concentrate formulations.
- refers to two-way mixtures. Adding a third product to a tank-mix, even if all are compatible with each other in two-way combinations, may result in incompatibility.
- may depend on the solvents and emulsifiers the manufacturer uses. Emulsifiable concentrates are more likely to cause compatibility problems than wettable powders.

Specifically:

- Add Captan or Maestro first when mixing with emulsifiable concentrate formulations of pyrethroids. Apply immediately with constant agitation.
- Do not mix pesticides with lime sulphur or streptomycin.
- Do not use oil sprays within 14 days of Captan or Maestro, including the oil used with Agri-Mek.

For more information on compatibility, contact the product manufacturer or distributor.

Jar test for pesticide compatibility

Always wear personal protective equipment (PPE) when performing a jar test for compatibility. Conduct the test in a safe and ventilated area, away from sources of ignition.

1. Using the same water you would use in the spray tank, measure 500 mL of water into a 1 L glass jar.
2. Add ingredients according to Table 11-3. *Tank-Mix Order for Pesticide Compatibility Test (in 500 mL of water)* on this page, stirring after each addition.
3. Let solution stand in a ventilated area for 15 minutes and observe results. The ingredients are likely not compatible if the mixture is giving off heat, gel or scum forms, or solids settle to the bottom (except for wettable powders).
4. If no signs of incompatibility appear, test the mixture using a spray bottle on a small area where it is to be applied. Look for phytotoxic indications such as plant damage, and monitor efficacy.

Tank water

- Mix pesticides with clean water that does not contain debris, sand, mud or organic matter.
- Never let the water-intake screen rest on a pond bottom when filling a sprayer.
- The water-intake line near the screen must, by law, have a check valve or anti-backflow device to prevent water-source contamination when the pump is shut off.
- Do not use a tank-refilling nozzle, volume-booster nozzle, or injection pump when refilling sprayer tanks from ponds or streams. These tank-refilling aids may contaminate the water source.
- When using a farm water supply, install a frost-free water hydrant outside the building. Place an anti-backflow valve or siphon prevention on the discharge end of the hydrant.
- If required, adjust the pH or hardness of the water before mixing spray materials in the tank. Where water is known to have an excessive salt content, compatibility of the water and the chemical at field strength should be tested first on a small scale.

Agitation

Agricultural products are formulated to be as emulsifiable as possible, but many do not mix well in water. They may contain elements that do not dissolve (e.g., wettable powders), may be petroleum distillates (e.g., emulsifiable concentrates), or are heavier than water and form precipitates (e.g., fertilizers and powdered metals). Consequently, good agitation is very important.

Table 11-3. Tank-Mix Order for Pesticide Compatibility Test (in 500 mL of water)

Order	Ingredient	Quantity of Product*
1	Compatibility agents	5 ml (1 tsp)
2	Wettable powders and dry flowables	15 g (1 tbsp)
3	Liquid drift retardants	5 ml (1 tsp)
4	Liquid concentrates, micro-emulsions and suspension concentrates	5 ml (1 tsp)
5	Emulsifiable concentrates	5 ml (1 tsp)
6	Water-soluble concentrates or solutions	5 ml (1 tsp)
7	Remaining adjuvants and surfactants	5 ml (1 tsp)

* Final ratio equivalent to 500 mL or 500 g of product in 1,000 L of final spray volume.

Effective agitation requires water to “sweep” the bottom of the tank so that any precipitated material is picked up and remixed. Turbulence is not enough. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation, the pesticide may foam or cause an invert emulsion (forming a gel).

There are two common types of agitation:

- **Mechanical agitation** is produced by paddles attached to a shaft mounted near the bottom of the spray tank. This system cannot always sweep the very bottom of the tank, so there is always some material that precipitates out of reach.
- **Hydraulic agitation** returns a portion of the pump output to the tank using volume-booster nozzles aimed at the centre line, so they sweep across the bottom. For hydraulic agitation to be effective, the agitator nozzle(s) should be fed by a dedicated line from the pressure side of the pump (not the pressure regulator) and have a valve to throttle the flow or completely shut it off to prevent foaming.

Filling the tank

Pesticide labels usually provide directions for mixing different materials, including the sequence for mixing. Unless otherwise specified (such as when using soluble pouches), follow the WALES method.

In a half-full tank with agitator running, add:

1. **W**ettable powders and flowables, including dissolvable packages

Fill tank to $\frac{3}{4}$ full, agitate and add:

2. **A**djuvants, such as anti-foaming compounds, buffers
3. **L**iquid and soluble products
4. **E**mulsifiable concentrates
5. **S**urfactants

Finish filling the spray tank to the required volume. Maintain continuous agitation during mixing and throughout application.

Clean the tank and sprayer with a detergent or solvent immediately after use, then flush thoroughly with clean water. To prevent oil build-up, empty the tank completely before refilling.

Spray drift

Do you know what pesticide drift looks like or what you can do about it? OMAF and CroPLife Canada have created two short videos with innovative visual demonstrations using dyes and night-spraying to show what drift actually looks like. See how spray particles behave and discover what changes can be made to your spray program to greatly reduce the risk of pesticide drift. Learn more at www.ontario.ca/spraydrift.

For more information on pesticide handling and operator safety, consult the Ontario Pesticide Education Program (OPEP) Grower Pesticide Safety course (www.opec.ca/index.cfm/learning-resources/farmers-learn-by-chapter).

Pesticides Used on Fruit Crops in Ontario

See Table 11-4. *Pesticides Used on Fruit Crops in Ontario by Active Ingredient* on this page, Table 11-5. *Pesticides Used on Fruit Crops in Ontario*, page 277, and Table 11-6. *Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario*, page 285.

Table 11-4. Pesticides Used on Fruit Crops in Ontario by Active Ingredient

Common Name/ Active Ingredient	TRADE or BRAND Name*	Common Name/ Active Ingredient	TRADE or BRAND Name*
abamectin	AGRI-MEK 1.9% EC	diazinon	DIAZINON 50 WSP, DIAZINON 500 E
acephate	ORTHENE 75% SP	difenoconazole	INSPIRE
acequinocyl	KANEMITE 15 SC	difenoconazole + cyprodinil	INSPIRE SUPER
acetamiprid	ASSAIL 70 WP	dimethoate	CYGON 480-AG, LAGON 480 E
ametoctradin + dimethomorph	ZAMPRO	dimethomorph	ACROBAT 50 WP
<i>Aureobasidium pullulans</i>	BLOSSOM PROTECT	dimethomorph + ametoctradin	ZAMPRO
azoxystrobin	QUADRIS	diphacinone	RAMIK BROWN
<i>Bacillus subtilis</i>	SERENADE MAX	dodine	EQUAL 65 WP, SYLLIT 400 FL
<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	BIOPROTEC CAF, DIPEL 2X DF, FORAY 48BA	endosulfan	THIONEX 50 WSP
bifenazate	ACRAMITE 50 WS	famoxadone + cymoxanil	TANOS 50 DF
boscalid	CANTUS WDG	fenbuconazole	INDAR
boscalid + pyraclostrobin	PRISTINE WG	fenhexamid	ELEVATE 50 WDG
calcium polysulphide	LIME SULPHUR	ferbam	FERBAM 76 WDG
captan	MAESTRO 80 DF, SUPRA CAPTAN 80 WDG	ferric phosphate	SLUGGO PROFESSIONAL
carbaryl	SEVIN XLR	flonicamid	BELEAF 50 SG
chlorantraniliprole	ALTACOR	fluazinam	ALLEGRO 500 F
chloropicrin	CHLOROPICRIN 100, PIC PLUS FUMIGANT	fludioxonil	SCHOLAR 230 SC
chlorothalonil	BRAVO 500, ECHO 720	fludioxonil + cyprodinil	SWITCH 62.5 WG
chlorpyrifos	LORSBAN 50 W, PYRINEX 480 EC, WARHAWK 480 EC	fluopicolide	PRESIDIO
citric acid + lactic acid	TIVANO	fluopyram + pyrimethanil	LUNA TRANQUILITY
clofentezine	APOLLO SC	folpet	FOLPAN 80 WDG
clothianidin	CLUTCH 50 WDG	fosetyl al	ALIETTE
copper hydroxide	KOCIDE 2000	garlic powder	BURAN
copper oxychloride	COPPER SPRAY, GUARDSMAN COPPER OXYCHLORIDE 50	imidacloprid	ADMIRE 240 F, ALIAS 240 SC
copper sulphate, tri-basic	COPPER 53 W	imidacloprid + deltamethrin	CONCEPT
cyantraniliprole	EXIREL	iprodione	ROVRAL WDG
<i>Cydia pomonella</i> granulovirus	CYD-X, VIROSOFT CP4	kaolin	SURROUND WP
cymoxanil + famoxadone	TANOS 50 DF	kasugamycin	KASUMIN 2L
cypermethrin	RIPCORD, UP-CYDE 2.5 EC	kresoxim-methyl	SOVRAN
cyprodinil	VANGARD 75 WG	lactic acid + citric acid	TIVANO
cyprodinil + difenoconazole	INSPIRE SUPER	lambda-cyhalothrin	SILENCER 120 EC, MATADOR 120 EC, WARRIOR
cyprodinil + fludioxonil	SWITCH 62.5 WG	malathion	MALATHION 25 W, MALATHION 85 E
deltamethrin	DECIS 5 EC	mancozeb	MANZATE PRO-STICK, DITHANE DG, PENNCOZEB 75 DF RAINCOAT
deltamethrin + imidacloprid	CONCEPT	mancozeb + metalaxyl	RIDOMIL GOLD MZ 68 WG

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Table 11-4. Pesticides Used on Fruit Crops in Ontario by Active Ingredient (cont'd)

Common Name/ Active Ingredient	TRADE or BRAND Name*	Common Name/ Active Ingredient	TRADE or BRAND Name*
mancozeb + zoxamide	GAVEL 75 DF	pyrimethanil + fluopyram	LUNA TRANQUILITY
mandipropamid	REVUS	quinoxifen	QUINTEC
metalaxyl-m and s-isomer	RIDOMIL GOLD 480 SL	<i>Reynoutria sachalinensis</i> extract	REGALIA MAXX
metalaxyl-m and s-isomer + mancozeb	RIDOMIL GOLD MZ 68 WG	spinetoram	DELEGATE WG
metam potassium	BUSAN 1180	spinosad	ENTRUST SC, ENTRUST 80 W, GF-120 FRUIT FLY BAIT, SUCCESS
metam sodium	VAPAM HL, BUSAN 1020, BUSAN 1236, ENFUSE M510	spirodiclofen	ENVIDOR 240 SC
metconazole	QUASH	spiromesifen	OBERON
methomyl	LANNATE TOSS-N-GO	spirotramat	MOVENTO 240 SC
methoxyfenozide	INTREPID 240 F	<i>Streptomyces lydicus</i>	ACTINOVATE SP
metiram	POLYRAM DF	streptomycin sulfate	STREPTOMYCIN 17
metrafenone	VIVANDO SC	sulfoxaflor	CLOSER SC
mineral oil	PURESpray GR N SPRAY OIL 13E, SUPERIOR 70 OIL	sulphur	KUMULUS DF, LIME SULPHUR, MICROSCOPIC SULPHUR, MICROSCOPIC WETTABLE SULPHUR, MICROTHIOL DISPERS
myclobutanil	NOVA 40 W	tebufenozide	CONFIRM 240 F
novaluron	RIMON 10 EC	tetraconazole	METTLE 125 ME
oriental mustard seed meal	MUSTGROW	thiabendazole	MERTECT SC
oxamyl	VYDATE L	thiacloprid	CALYPSO 480 SC
<i>Pantoea agglomerans</i>	BLOOMTIME BIOLOGICAL FD	thiamethoxam	ACTARA 25 WG
pen thiopyrad	FONTELIS	thiophanate methyl	SENATOR 70 WP
permethrin	AMBUSH 500 EC, PERM-UP, POUNCE 384 EC	thiram	GRANUFLO T, SKOOT, THIRAM 75 WP
pheromone	ISOMATE-CM/OFM TT, ISOMATE-DWB, ISOMATE- GBM PLUS, ISOMATE-M 100, ISOMATE-M ROSSO, ISOMATE- PTB DUAL	trifloxystrobin	FLINT
phosmet	IMIDAN 70-WP INSTAPAK	triforine	FUNGINEX DC
phosphites, ammonium, potassium, mono- and di-basic sodium	PHOSTROL	zinc phosphide	BARTLETT WAXED MOUSE BAIT
phosphorous acid, mono- and di-potassium salts of phosphorous acid	CONFINE EXTRA, RAMPART	zoxamide + mancozeb	GAVEL 75 DF
potassium bicarbonate	MILSTOP, SIROCCO		
potassium salts of fatty acids	OPAL		
prohexadione calcium	APOGEE		
propiconazole	JADE, MISSION 418 EC, TOPAS		
prothioconazole	PROLINE 480 SC		
<i>Pseudomonas syringae</i>	BIO-SAVE 10 LP		
pyraclostrobin	CABRIO EG		
pyraclostrobin + boscalid	PRISTINE WG		
pyrethrins	PYGANIC EC 1.4II		
pyridaben	NEXTER		
pyrimethanil	SCALA SC		

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Table 11-5. Pesticides Used on Fruit Crops in Ontario

Registration No.	TRADE or BRAND Name ^a	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
27925	ACRAMITE 50 WS	bifenazate	a	CG 12, CG 13-07A, CG 14, apple, grape	WSP	50%	4	CRE
27700	ACROBAT 50 WP	dimethomorph	f	grape	D	50%	3	BAZ
28408	ACTARA 25 WG	thiamethoxam	i	CG 13-07A, CG 13-07B, CG 13-07G, apple, pear, sweet cherry	D	25%	3	SYZ
28672	ACTINOVATE SP	<i>Streptomyces lydicus</i> strain WYEC108	f	strawberry	D	0.037%	4	MGS, NBL
24094	ADMIRE 240 F	imidacloprid	i	CG 11-09, CG 12, CG 13A, CG 13B, CG 13-07F, CG 13-07G, CG 14, Saskatoon berry	L	240 g/L	4	BCZ
24551	AGRI-MEK 1.9% EC	abamectin	a,i	CG 13A, apple, grape, pear, strawberry	EC	19 g/L	3	SYZ
28475	ALIAS 240 SC	imidacloprid	i	CG 13A, apple, blueberry, cherry, peach, Saskatoon berry, strawberry	L	240 g/L	4	MKC, UAG
27688	ALIETTE	fosetyl al	f	apple, blueberry, grape, raspberry, strawberry	D	80%	3	BCZ
27517	ALLEGRO 500 F	fluazinam	f	apple, blueberry, currant, elderberry, gooseberry	L	40%	3	ISK, SYZ
28981	ALTACOR	chlorantraniliprole	i	CG 11, CG 12, CG 13-07A, CG 13-07B, CG 13-07G, CG 14, grape	D	35%	2	DUQ
14882	AMBUSH 500 EC	permethrin	i	apple, grape, peach, pear, plum	EC	500 g/L	4	AMV, ENG
28042	APOGEE	prohexadione calcium	pgr	apple, cherry	D	27.5%	4	BAZ
21035	APOLLO SC	clofentezine	a	apple, peach, pear, raspberry, strawberry	L	500 g/L	3	MKC, UAG
27128	ASSAIL 70 WP	acetamiprid	i	CG 11, CG 12, CG 13-07B, grape, strawberry	D	70%	4	ENG, NPS
8024	BARTLETT WAXED MOUSE BAIT	zinc phosphide	r	orchards	P	2%	3	BAT
29796	BELEAF 50 SG	flonicamid	i	CG 11, CG 12	D	50%	4	ISK, UAG
26854	BIOPROTEC CAF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i	CG-13-07, apple, apricot, cherry, grape, hazelnut, peach, pear, pecan, plum, sweet chestnut, walnut	L	12.7 BIU/L	3	AFG, UAG
29673	BIO-SAVE 10 LP	<i>Pseudomonas syringae</i> strain ESC-10	f	apple, cherry, pear	D	9 x 10 ¹⁰ CFU/g	4	JET
28436	BLOOMTIME BIOLOGICAL FD	<i>Pantoea agglomerans</i> strain E325	ba	CG 13A, apple, pear, Saskatoon berry	D	1 x 10 ¹⁰ CFU/g	4	NAQ

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¹ a = acaricide, miticide. b = bactericide. ba = bacterial antagonist. f = fungicide. h = herbicide. i = insecticide. n = nematocide.

r = rodenticide. md = mating disrupter. pgr = plant growth regulator. s = slug bait. tr = taste repellent.

² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

³ D = dry formulations (including wettable granule, wettable powder, water-dispersible granule). DIS = dispenser units. EC = emulsifiable concentrate.

L = liquid formulations (including liquid, suspension concentrate, solution, suspension, micro-emulsion). P = particulate/pellet. WSP = water-soluble packets.

⁴ See Table 11-7: Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4, page 286.

⁵ See Table 11-8: Pest Control Product Companies, page 287 for registrant or distributor information.

Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name*	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
30552	BLOSSOM PROTECT	<i>Aureobasidium pullulans</i> strains DSM 14940 and DSM 14941	ba	CG 11-09	D	5 x 10 ⁹ CFU/g	3	BFG, UAG
15723	BRAVO 500	chlorothalonil	f	blueberry, cherry, filbert, hazelnut, peach, strawberry	L	500 g/L	4	SYZ
30601	BURAN	garlic powder	f	apple, grape, pear	L	15%	NC	AFG
19421	BUSAN 1020	metam sodium	f,h,n	fruit crops (before planting)	L	33%	4	BUL
25124	BUSAN 1180	metam potassium	f,h,n	fruit crops (before planting)	L	54%	3	BUL
25103	BUSAN 1236	metam sodium	f,h,n	fruit crops (before planting)	L	42.5%	4	BUL
27323	CABRIO EG	pyraclostrobin	f	CG 12, blueberry, strawberry	D	20%	4	BAZ
28429	CALYPSO 480 SC	thiacloprid	i	CG 11	L	480 g/L	3	BCZ
30141	CANTUS WDG	boscalid	f	CG 12, CG 13, grape, strawberry	D	70%	2	BAZ
25863	CHLOROPICRIN 100	chloropicrin	f,n	raspberry, strawberry (before planting)	L	99%	2	DAS, HND
30826	CLOSER SC	sulfoxaflor	i	CG 11-09, CG 12-09, CG 14-11, grape	L	240 g/L	3	DWE
29382	CLUTCH 50 WDG	clothianidin	i	CG 11, CG 12, grape, strawberry	D	50%	2	VAJ
29611	CONCEPT	imidacloprid + deltamethrin	i	blueberry	L	75 g/L + 10 g/L	3	BCZ
30648	CONFINE EXTRA	mono- and di-potassium salts of phosphorous acid	f	blueberry, grape, strawberry	L	53%	4	ACC
24503	CONFIRM 240 F	tebufenozide	i	apple, pear	L	240 g/L	3	GOW, NPS, UAG
9934	COPPER 53 W	tri-basic copper sulphate	b, f	apple, currant, gooseberry, grape, peach, pear, raspberry, sour cherry, strawberry	D	53%	3	LVP, UAG
19146	COPPER SPRAY	copper oxychloride	f	apple, blueberry, cherry, filbert, hazelnut, grape, peach, raspberry, walnut	D	50%	4	LVP, UAG
30120	CYD-X	<i>Cydia pomonella</i> granulovirus	i	apple	L	0.06%	3	CIT, ENG
25651	CYGON 480-AG	dimethoate	i	blueberry, cherry, filbert, hazelnut, pear, strawberry	EC	480 g/L	3	CAU
22478	DECIS 5 EC	deltamethrin	i	apple, blueberry, peach, pear, strawberry	EC	50 g/L	3	BCZ
28778	DELEGATE WG	spinetoram	i	CG 11, CG 12, CG 14, blueberry, grape, raspberry, strawberry	D	25%	3	DWE

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r = rodenticide. md = mating disrupter. pgr = plant growth regulator. s = slug bait. tr = taste repellent.

² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

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⁵ See Table 11-8. Pest Control Product Companies, page 287 for registrant or distributor information.

Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name*	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
29976	DIAZINON 50 WSP	diazinon	i	CG 13A, apple, cherry, currant, gooseberry, peach, pear, plum, strawberry	WSP	50%	3	LVP, UAG
11889	DIAZINON 500 E	diazinon	i	CG 13A, apple, cherry, currant, gooseberry, peach, pear, plum, strawberry	EC	500 g/L	3	LVP, UAG
26508	DIPEL 2X DF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i	CG 13-07, apple, apricot, cherry, filbert, hazelnut, grape, pecan, pear, plum, sweet chestnut, walnut	D	32 BIU/kg	4	VAA, VAJ
29221	DITHANE DG	mancozeb	f	apple	D	75%	4	DWE
29355	ECHO 720	chlorothalonil	f	blueberry, peach, sour cherry, strawberry	L	720 g/L	4	UAG
25900	ELEVATE 50 WDG	fenhexamid	f	CG 13A, CG 13B, cherry, grape, peach, strawberry	D	50%	3	TOA, UAG
29142	ENFUSE M 510	metam sodium	f, h, n	fruit crops (before planting)	L	42%	4	ENG, TAO
27825	ENTRUST 80 W	spinosad	i	CG 11, CG 12, CG 13-07A, CG 13-07B, CG 13-07G, grape, walnut	D	80%	3	DWE
30382	ENTRUST SC	spinosad	i	CG 11, CG 12, grape	L	240 g/L	4	DWE
28051	ENVIDOR 240 SC	spirodiclofen	a	CG 11, CG 12, CG 14, blueberry, grape	L	240 g/L	4	BCZ
15608	EQUAL 65 WP	dodine	f	apple, cherry, pear	D	65%	4	ENG, NRA
30895	EXIREL	cyantraniliprole	i	CG 11-09, CG 12-09, CG 13-07B, CG 14-11	L	100 g/L	3	DUQ
20136	FERBAM 76 WDG	ferbam	f	apple, apricot, blueberry, cherry, currant, grape, peach, pear, plum, raspberry	D	76%	4	LVP, UAG
30619	FLINT	trifloxystrobin	f	CG 11, CG 12, hazelnut, grape, strawberry	D	50%	4	BCZ
27733	FOLPAN 80 WDG	folpet	f	apple, grape, strawberry	D	80%	4	MKC, UAG
30331	FONTELIS	penthiopyrad	f	CG 11, CG 12, CG 13-07G, filbert, hazelnut, sweet chestnut, walnut	L	200 g/L	4	DUQ
24978	FORAY 48BA	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i	apple, blueberry, pear, raspberry	L	10 BIU/kg	4	VAA
27686	FUNGINEX DC	triforine	f	apple (non-bearing), blueberry, cherry, peach, plum, saskatoon berry	EC	190 g/L	3	ENG

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² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

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Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name*	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
26842	GAVEL 75 DF	zoxamide + mancozeb	f	grape	D	8.4% + 66.7%	4	GOW, UAG
28336	GF-120 FRUIT FLY BAIT	spinosad	i	apple, blueberry, cherry, walnut	L	0.02%	4	DWE
30548	GRANUFLO-T	thiram	f	apple, peach, plum, strawberry	D	75%	3	ENG, TAO
13245	GUARDSMAN COPPER OXYCHLORIDE 50	copper oxychloride	f	blueberry, cherry, filbert, hazelnut, grape, peach, raspberry	D	50%	3	VAR
29064	IMIDAN 70-WP INSTAPAK	phosmet	i	apple, blueberry, grape, peach, pear, plum, sour cherry	WSP	70%	3	GOW, UAG
27294	INDAR	fenbuconazole	f	CG 12	WSP	75%	2	DWE
30004	INSPIRE	difenoconazole	f	apple, grape, pear	EC	250 g/L	3	SYZ
30827	INSPIRE SUPER	difenoconazole + cyprodinil	f	apple, pear	L	86 g/L + 249 g/L	2	SYZ
27786	INTREPID 240 F	methoxyfenozide	i	CG 11-09, CG 12-09, CG 13-07B, CG 14-11, grape	L	240 g/L	3	DWE
29352	ISOMATE-CM/OFM TT	pheromone, oriental fruit moth and codling moth	md	CG 11, CG 12, walnut	DIS	92%	4	PBC
30589	ISOMATE-DWB	pheromone, dogwood borer	md	CG 11, CG 12-09, blueberry, pecan, filbert, sweet chestnut, walnut	DIS	87.1%	4	PBC
27525	ISOMATE-GBM PLUS	pheromone, grape berry moth	md	grape	DIS	91.1%	4	PBC
26981	ISOMATE-M 100	pheromone, oriental fruit moth	md	apple, apricot, peach, pear	DIS	95.2%	4	PBC
27339	ISOMATE-M ROSSO	pheromone, oriental fruit moth	md	apple, apricot, peach, pear	DIS	95.2%	4	PBC
30042	ISOMATE-PTB DUAL	pheromone, peachtree borer and lesser peachtree borer	md	CG 12-09	DIS	87.9%	4	PBC
24030	JADE	propiconazole	f	CG 13-A, apricot, blueberry, cherry, peach, plum, saskatoon berry, strawberry	EC	250 g/L	3	ENG
28641	KANEMITE 15 SC	acequinocyl	a	CG 13-07A, apple, filbert, hazelnut, pear, pecan, sweet chestnut, walnut	L	15.8%	3	TOA, UAG
30591	KASUMIN 2L	kasugamycin	b	CG 11-09, walnut	L	2.0%	3	TOA, UAG
27348	KOCIDE 2000	copper hydroxide	b,f	grape	D	53.8%	3	DUQ
18836	KUMULUS DF	sulphur	a,f	apple, cherry, grape, peach, pear, plum, saskatoon berry	D	80%	4	BAZ

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Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name ^a	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
9382	LAGON 480 E	dimethoate	i	blueberry, cherry, filbert, hazelnut, peach, pear, strawberry	EC	480 g/L	3	LVP, UAG
10868	LANNATE TOSS-N-GO	methomyl	i	apple	WSP	90%	2	DUQ
16465	LIME SULPHUR	calcium polysulphide	f,i	apple, blueberry, cherry, gooseberry, grape, peach, pear, plum, raspberry, strawberry	L	30%	4	LVP, UAG
20944	LORSBAN 50 W	chlorpyrifos	i	peach, strawberry	WSP	50%	3	DWE
30510	LUNA TRANQUILITY	fluopyram + pyrimethanil	f	apple, grape	L	125 g/L + 375 g/L	2	BCZ
26408	MAESTRO 80 DF	captan	f	apple, apricot, blueberry, cherry, grape, peach, pear, plum, raspberry, strawberry	D	80%	3	TOA
14656	MALATHION 25 W	malathion	i	apple, blueberry, cherry, currant, gooseberry, peach, pear, plum, raspberry, strawberry	D	25%	4	LVP, UAG
8372	MALATHION 85 E	malathion	i	apple, apricot, blueberry, cherry, grape, peach, pear, plum, raspberry, strawberry	EC	85%	3	LVP, UAG
28217	MANZATE PRO-STICK	mancozeb	f	apple, grape	D	75%	3	UPI
24984	MATADOR 120 EC	lambda-cyhalothrin	i	apple, cherry, peach, pear, plum, strawberry	EC	120 g/L	2	SYZ
13975	MERTECT SC	thiabendazole	f	apple, pear	L	500 g/L	4	SYZ
30673	METTLE 125 ME	tetraconazole	f	gooseberry, grape, strawberry	L	125 g/L	2	TOA
14653	MICROSCOPIC SULPHUR	sulphur	f	apple, cherry, currant, gooseberry, grape, peach, pear, plum, sea buckthorn	D	92%	4	LVP, UAG
873	MICROSCOPIC WETTABLE SULPHUR	sulphur	f	apple, cherry, grape, peach, pear, plum	D	92%	4	BAT
29487	MICROTHIOL DISPERS	sulphur	a,f	apple, cherry, grape, peach, pear, plum, saskatoon berry	D	80%	4	UAG, UPI
28095	MILSTOP	potassium bicarbonate	f	apricot, grape, peach, plum	D	85%	4	BWI
28016	MISSION 418 EC	propiconazole	f	CG 13A, apricot, blueberry, cherry, peach, plum, blueberry, saskatoon berry, strawberry	EC	418 g/L	3	MKC, UAG
28953	MOVENTO 240 SC	spirotetramat	i	CG 11-09, CG 12, CG 13-07B, CG 13-07H, CG 14, grape	L	240 g/L	4	BCZ
30263	MUSTGROW	oriental mustard seed meal	f,n	CG 13-07A, strawberry	P	100%	3	MQT

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Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name*	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
25135	NEXTER	pyridaben	a,i	apple, cherry, grape, peach, pear, raspberry, strawberry	WSP	75%	3	GOW, UAG
22399	NOVA 40 W	myclobutanil	f	apple, cherry, grape, peach, pear, saskatoon berry, strawberry	WSP	40%	3	DWE, UAG
28905	OBERON	spiromesifen	a	strawberry	L	240 g/L	3	BCZ
28146	OPAL	potassium salts of fatty acids	a,i	apple, apricot, blueberry, cherry, filbert, hazelnut, grape, peach, pear, plum, pecan, raspberry, strawberry, sweet chestnut, walnut	L	47%	4	ENG, OMD
14225	ORTHENE 75% SP	acephate	i	saskatoon berry	D	75%	3	TOA, UAG
30241	PENNCOZEB 75 DF RAINCOAT	mancozeb	f	apple, grape	D	75%	3	UAG, UPI
28877	PERM-UP	permethrin	i	apple, grape, peach, pear, plum	EC	384 g/L	3	UPI
30449	PHOSTROL	mono- and di-basic sodium, potassium and ammonium phosphites	f	grape, raspberry, strawberry	L	53.6	4	ENG
28715	PIC PLUS FUMIGANT	chloropicrin	f,n	strawberry, raspberry	L	85.1%	2	DAS, HND
20087	POLYRAM DF	metiram	f	apple, grape	D	80%	4	BAZ
16688	POUNCE 384 EC	permethrin	i	apple, grape, peach, pear, plum	EC	384 g/L	4	FMC, UAG
30051	PRESIDIO	fluopicolide	f	grape	L	39.5%	2	VAJ
27985	PRISTINE WG	boscalid + pyraclostrobin	f	CG 11, CG 12, CG 13, grape, saskatoon berry, strawberry	D	25.2% + 12.8%	2	BAZ
28359	PROLINE 480 SC	prothioconazole	f	CG 13-07B	L	480 g/L	3	BCZ
27666	PURESpray GREEN SPRAY OIL 13E	mineral oil	f,i	apple, apricot, blueberry, cherry, grape, peach, pear, plum	L	99%	4	PCV
30164	PYGANIC EC 1.4II	pyrethrins	i	blueberry, grape, raspberry	EC	1.4%	4	MGK
23705	PYRINEX 480 EC	chlorpyrifos	i	filbert, strawberry	EC	480 g/L	3	MKC, UAG
26153	QUADRIS	azoxystrobin	f	filbert, hazelnut, strawberry	L	250 g/L	3	SYZ
30402	QUASH	metconazole	f	blueberry, currants, elderberry, sea buckthorn	WSP	50%	3	VAJ
29755	QUINTEC	quinoxifen	f	CG 12, grape, strawberry	L	250 g/L	3	DWE
11670	RAMIK BROWN	diphacinone	r	orchards	P	0.005%	4	HOK, UAG

* Mention of a TRADE or BRAND name does not constitute a guarantee or warranty of the product by the Ontario Crop Protection Committee or the Ontario Ministry of Agriculture and Food.

¹ a = acaricide, miticide. b = bactericide. ba = bacterial antagonist. f = fungicide. h = herbicide. i = insecticide. n = nematode.

r = rodenticide. md = mating disrupter. pgr = plant growth regulator. s = slug bait. tr = taste repellent.

² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

³ D = dry formulations (including wettable granule, wettable powder, water-dispersible granule). DS = dispenser units. EC = emulsifiable concentrate.

L = liquid formulations (including liquid, suspension concentrate, solution, suspension, micro-emulsion). P = particulate/pellet. WSP = water-soluble packets.

⁴ See Table 11-7. Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4, page 286.

⁵ See Table 11-8. Pest Control Product Companies, page 287 for registrant or distributor information.

Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name*	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
30654	RAMPART	mono- and di-potassium salts of phosphorous acid	f	grape	L	53%	4	LVP, UAG
30199	REGALIA MAXX	<i>Reynoutria sachalinensis</i> extract	f	grape, strawberry	L	20%	3	ENG, MQO
29074	REVUS	mandipropamid	f	grape	L	250 g/L	3	SYZ
28474	RIDOMIL GOLD 480 SL	metalaxyl-m and s-isomer	f	non-bearing apple, blueberry, raspberry, strawberry	L	480 g/L	3	SYZ
28893	RIDOMIL GOLD MZ 68 WG	metalaxyl-m and s-isomer + mancozeb	f	grape	D	4% + 64%	3	SYZ
28515 28881	RIMON 10 EC	novaluron	i	CG 12, CG 13-07B, apple, strawberry	EC	10%	2	CRE, MKC, UAG
30316	RIPCORD	cypermethrin	i	apple, grape, peach, pear, strawberry	EC	407 g/L	4	ENG
24709	ROVRAL WDG	iprodione	f	apricot, cherry, grape, peach, plum, raspberry, strawberry	D	500 g/kg	3	FMC, UAG
28011	SCALA SC	pyrimethanil	f	CG 11, blueberry, gooseberry, grape, raspberry, strawberry	L	400 g/L	3	BCZ
29528	SCHOLAR 230 SC	fludioxonil	f	CG 11, CG 12, strawberry	L	230 g/L	4	SYZ
25343	SENATOR 70 WP	thiophanate-methyl	f	apple, cherry, peach, pear, plum, raspberry, strawberry	D	70%	4	ENG, NPS
28549	SERENADE MAX	<i>Bacillus subtilis</i> strain QST 713	f	CG 11, CG 12, CG 13A, CG 13B, grape, saskatoon berry, sea buckthorn, strawberry	D	7.3 x 10 ⁹ CFU/g	4	BCZ
27876	SEVIN XLR	carbaryl	i	apple, apricot, blueberry, cherry, grape, peach, pear, plum, raspberry, strawberry	L	466 g/L	3	TKI
29052	SILENCER 120 EC	lambda-cyhalothrin	i	apple, cherry, peach, pear, plum, strawberry	EC	120 g/L	2	MKC, UAG
31091	SIROCCO	potassium bicarbonate	f	apricot, grape, peach, plum	D	85%	4	AFG
13258	SKOOT	thiram	tr	apple, cherry, plum, saskatoon berry, walnut	L	120 g/L	4	MGS
30025	SLUGGO PROFESSIONAL	ferric phosphate	s	fruit crops	P	0.76%	4	ENG
26257	SOVRAN	kresoxim-methyl	f	apple, pear, grape	D	50%	4	BAZ
10305	STREPTOMYCIN 17	streptomycin sulphate	b	apple, pear	D	25.2%	4	LVP, UAG
26835	SUCCESS	spinosad	i	CG 11, CG 12, CG 13-07A, CG 13-07B, CG 13-07G, grape	L	480 g/L	4	DWE
9542	SUPERIOR 70 OIL	mineral oil	a,i	apple, apricot, blueberry, peach, pear, plum, saskatoon berry, sour cherry	EC	99%	4	BAT

* Mention of a TRADE or BRAND name does not constitute a guarantee or warranty of the product by the Ontario Crop Protection Committee or the Ontario Ministry of Agriculture and Food.

¹ a = acaricide, miticide. b = bactericide. ba = bacterial antagonist. f = fungicide. h = herbicide. i = insecticide. n = nematocide.

r = rodenticide. md = mating disrupter. pgr = plant growth regulator. s = slug bait. tr = taste repellent.

² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

³ D = dry formulations (including wettable granule, wettable powder, water-dispersible granule). DIS = dispenser units. EC = emulsifiable concentrate.

L = liquid formulations (including liquid, suspension concentrate, solution, suspension, micro-emulsion). P = particulate/pellet. WSP = water-soluble packets.

⁴ See Table 11-7. Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4, page 286.

⁵ See Table 11-8. Pest Control Product Companies, page 287 for registrant or distributor information.

Table 11-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration No.	TRADE or BRAND Name ^a	Common Name/ Active Ingredient	Use ¹	Crop or Crop Group (CG) Registrations ²	Formulation ³	Guaranteed Active	Ont. Class ⁴	Registrant/ Distributor Code ⁵
14981	SUPERIOR 70 OIL	mineral oil	a,i	apple, apricot, blueberry, peach, pear, plum, sour cherry	EC	99%	4	LVP, UAG
24613	SUPRA CAPTAN 80 WDG	captan	f	apple, apricot, blueberry, cherry, grape, peach, pear, plum, raspberry, strawberry	D	80%	3	LVP, UAG
27469	SURROUND WP	kaolin	i	apple, grape, hazelnut, pear, pecan, raspberry, strawberry, sweet chestnut, walnut	D	95%	4	BAT, TKI
28189	SWITCH 62.5 WG	cyprodinil + fludioxonil	f	blueberry, grape, raspberry, saskatoon berry, strawberry	D	37.5% + 25%	3	SYZ
28351	SYLLIT 400 FL	dodine	f	apple, pear	D	402 g/L	4	CIB, ENG, NRA
27435	TANOS 50 DF	famoxadone + cymoxanil	f	CG 13-07A	D	25% + 25%	3	DUQ
29990	THIONEX 50 WSP	endosulfan	i	apricot, cherry, peach, plum, strawberry	WSP	50%	2	LVP, UAG
27556	THIRAM 75 WP	thiram	f	apple, peach, plum, strawberry	D	75%	3	CRE, UAG
30468	TIVANO	citric acid + lactic acid	b, f	grape, strawberry	L	10.73 g/L + 21/37 g/L	4	AFG, UAG
30163	TOPAS	propiconazole	f	CG 13A, apricot, blueberry, cherry, peach, plum, saskatoon berry, strawberry	EC	250 g/L	3	SYZ
28795	UP-CYDE 2.5 EC	cypermethrin	i	apple, grape, peach, pear, plum, strawberry	EC	250g/L	3	UAG, UPI
25509	VANGARD 75 WG	cyprodinil	f	apple, apricot, grape, peach, plum	D	75%	3	SYZ
29128	VAPAM HL	metam sodium	f, h, n	fruit crops (before planting)	L	42%	4	AMV, UAG
26533	VIROSOFT CP4	<i>Cydia pomonella</i> granulovirus	i	apple	L	0.07%	4	BPT
29765	VIVANDO SC	metrafenone	f	grape	L	300 g/L	2	BAZ
17995	VYDATE L	oxamyl	i,n	non-bearing apple, raspberry	L	240 g/L	2	DUQ
29984	WARHAWK 480 EC	chlorpyrifos	i	filbert, hazelnut, strawberry	EC	480 g/L	3	LVP, UAG
26837	WARRIOR	lambda-cyhalothrin	i	apple, cherry, peach, pear, plum, saskatoon berry, strawberry	L	122 g/L	2	SYZ
30321	ZAMPRO	dimethomorph + ametoctradin	f	grape	L	225 g/L + 300 g/L	3	BAZ

^a Mention of a TRADE or BRAND name does not constitute a guarantee or warranty of the product by the Ontario Crop Protection Committee or the Ontario Ministry of Agriculture and Food.

¹ a = acaricide, miticide. b = bactericide. ba = bacterial antagonist. f = fungicide. h = herbicide. i = insecticide. n = nematocide.

r = rodenticide. md = mating disrupter. pgr = plant growth regulator. s = slug bait. tr = taste repellent.

² See Appendix C: Crop Groupings for Pesticide Registrations in Canada, page 293 for full listing of crops within each crop group (CG).

³ D = dry formulations (including wettable granule, wettable powder, water-dispersible granule). DIS = dispenser units. EC = emulsifiable concentrate.

L = liquid formulations (including liquid, suspension concentrate, solution, suspension, micro-emulsion). P = particulate/pellet. WSP = water-soluble packets.

⁴ See Table 11-7. Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4, page 286.

⁵ See Table 11-8. Pest Control Product Companies, page 287 for registrant or distributor information.

Table 11-6. Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario

Registration No.	TRADE or BRAND Name ^a	Common Name or Active Ingredient	Use ¹	Guaranteed Active	Formulation ²	Ont. Class ³	Registrant/ Distributor Code ⁴
28042	APOGEE	prohexadione calcium	PGR	27.5%	D	4	BAZ
29210	CILIS PLUS	6-benzylaminopurine	PGR, TH	2.0%	L	4	BAT, FAL
11580	ETHREL	ethephon	PGR	240 g/L	L	4	BCZ
27653	FALGRO TABLET	gibberellic acid	PGR	1.0 g/tablet	tablet	4	NRA
14630	FRUITONE N	1-naphthaleneacetic acid	PGR, TH	3.1%	D	4	AMV, UAG
28851	MAXCEL	6-benzyladenine	PGR, TH	1.9%	L	4	VAA, VAJ
29187	PERLAN	6-benzylaminopurine, gibberellins A ₁ + A ₇	PGR	1.8% BA 1.8% GA	L	4	BAT, FAL
16636	PROMALIN	benzyladenine gibberellins A ₁ + A ₇	PGR	1.8% BA 1.8% GA	EC	4	VAA, VAJ
25609	RETAIN	aviglycine hydrochloride	PGR	15%	D	3	VAA, VAJ
27469	SURROUND WP	kaolin	CP	95%	D	4	BAT, TKI

^a Mention of a BRAND or TRADE name does not constitute a guarantee or warranty of the product by the Ontario Crop Protection Committee or the Ontario Ministry of Agriculture and Food.

¹ PGR = plant growth regulator. TH = thinner. CP = crop protectant.

² D = dry formulation (including wettable granule, wettable powder). EC = emulsifiable concentrate. L = liquid formulation (including solution).

³ Farmers must be certified to buy and use pesticides in Class 2 and 3. See Table 11-7, *Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4*, page 286.

⁴ See Table 11-8, *Pest Control Product Companies*, page 287 or registrant or distributor information.

Pesticide Classification in Ontario

Under the *Pesticides Act* and Regulation 63/09, the Ontario Ministry of the Environment classifies federally registered pesticides into one of 11 classes. Each class has defined education, licensing and/or permit requirements, and restrictions on its use and sale in Ontario. Pesticides are classified on the basis of their toxicity, environmental or health hazard, persistence, concentration, how they are used, and their container size. The classification of each product in the publication can be found in Table 11-5. *Pesticides Used on Fruit Crops in Ontario*, page 277 and Table 11-6. *Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario* on page 285.

Class 2 and 3 pesticides are the most hazardous. Table 11-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3 and 4* on this page describes the hazard criteria for the classes of pesticides used in this publication. Regulation 63/09 of the *Pesticides Act* makes it mandatory for farmers to be certified to buy and use Class 2 or 3 pesticides on their farms. Pesticide storage requirements also vary by class. Detailed descriptions of each classification can be found at: www.ontario.ca/pesticides.

A farmer can become certified by attending a one-day Grower Pesticide Safety Course and passing the certification examination. To become a certified farmer, visit the Ontario Pesticide Education Program website at www.oppep.ca or call 1-800-652-8573.

Table 11-7. Pesticide Classification Schedules In Ontario: Classes 2, 3 and 4

Provincial Class	Federal Class	Hazard Description	Hazard Criteria
2	Restricted or Commercial	Very Hazardous	Meets at least one of these criteria: • fumigant gas • acute oral LD₅₀ less than or equal to 50 mg/kg • acute dermal LD₅₀ less than or equal to 100 mg/kg • soil half-life greater than or equal to 6 months
3	Restricted or Commercial	Moderately Hazardous	Meets at least one of these criteria: • acute oral LD₅₀ greater than 50 and less than or equal to 500 mg/kg • acute dermal LD₅₀ greater than 100 and less than or equal to 1,000 mg/kg • soil half-life greater than 1 month and less than 6 months
4	Restricted or Commercial	Less or Least Hazardous	Meets all of these criteria: • acute oral LD₅₀ greater than 500 mg/kg • acute dermal LD₅₀ greater than 1,000 mg/kg • soil half-life less than or equal to 1 month

Source: Pesticide Classification Guideline for Ontario (2009).

Pest Control Product Companies

See Table 11-8. *Pest Control Product Companies* on this page for pest control product registrant or distributor contact information. The 3-letter codes represent the codes listed in Table 11-5. *Pesticides Used on Fruit Crops in Ontario*, page 277 and Table 11-6. *Thinners and Growth Regulators Used on Fruit Crops in Ontario*, page 285. For Canadian labels, contact the registrant/distributor or search the PMRA website at: www.pmra-arla.gc.ca/english/main/search-e.html.

Table 11-8. Pest Control Product Companies

Code	Registrant or Distributor	Website	Contact Number
ACC	Agronomy Company of Canada	www.agromartgroup.com	519-461-9057
AFG	AEF Global Inc.	www.aefglobal.com	418-838-4441
AMV	AMVAC Chemical Corporation	www.ecozin.com (U.S. website)	323-264-3910
BAT	Bartlett, N.M. Inc.	www.bartlett.ca	1-800-263-1287
BAZ	BASF Canada Inc.	www.agsolutions.ca	1-877-371-2273
BCZ	Bayer CropScience Inc.	www.bayercropscience.ca	1-877-938-3737
BFG	Bio-Ferm GmbH	www.bio-ferm.com	
BPT	BioTepp Inc.	www.biotepp.com	418-659-4446
BUL	Buckman Laboratories of Canada Ltd.	www.buckman.com	450-424-4404
BWI	Bioworks	www.bioworksbiocontrol.com	585-641-0581
CAU	Cheminova Canada Inc.	www.cheminova.com	1-888-316-6260
CRE	Chemtura Company	www.chemtura.com	403-279-7477
CIB	Chimac-Agriphar S.A.	www.agriphar.com	
CIT	Certis USA	www.certisusa.com (U.S. website)	1-800-847-5620
DAS	Douglas Agricultural Services, Inc.	—	519-427-8195
DUQ	E.I. du Pont Canada Company	www.dupont.ca/ag	1-800-667-3925
DWE	Dow AgroSciences Canada	www.dowagro.com	1-800-667-3852
ENG	Engage Agro Corp.	www.engageagro.com	1-866-613-3336
FAL	Fine Agrochemicals Inc.	www.fine-america.com	925-932-8800
FMC	FMC Corporation	www.fmc.com	1-800-845-0187
GOW	Gowan Company	www.gowanco.com	1-800-883-1844
HND	Hendrix and Dail Inc.	www.hendrixanddail.com	831-637-0195
HOK	Hacco Inc.	www.hacco.com (U.S. website)	920-326-2461
ISK	ISK Biosciences Corporation	www.iskbc.com (U.S. website)	216-357-4100
JET	Jet Harvest Solutions	www.jetharvest.com	1-877-866-5773
LVP	Loveland Products Canada Inc.	www.lovelandproducts.com (U.S. website)	1-800-328-4678
MGK	McLaughlin Gormley King Co.	www.mgk.com	1-800-645-6466
MGS	MGS Horticulture Inc.	www.mgshort.com	1-800-387-2449
MKC	Makhteshim-Agan	www.manainc.ca	905-304-1168
MQO	Marrone Bio Innovations, Inc.	www.marronebioinnovations.com	1-877-664-4476
MQT	MPT Mustard Products & Technologies, Inc.	www.mptmustardproducts.com	306-668-2652
NAQ	Northwest Agricultural Products	www.nap-chem.com	1-877-357-4461
NBL	Novozymes BioAg Limited	www.bioag.novozymes.com	1-888-744-5662
NIJ	Natural Industries Inc.	www.naturalindustries.com	281-580-1643
NPS	Nippon Soda Co., Ltd.	www.nippon-soda.co.jp (Japan website)	212-490-0350
NRA	Norac Concepts	www.noracconcepts.com	519-821-3110
OMD	Omex Agriculture Inc.	www.omex.co.uk/canada/home.aspx	204-477-4052
PBC	Pacific Biocontrol	www.pacificbiocontrol.com (U.S. website)	360-571-2247

— = No information is available.

Table 11-8. Pest Control Product Companies (cont'd)

Code	Registrant or Distributor	Website	Contact Number
PCV	Petro-Canada Lubricants	www.purespraygreen.com	905-804-3600
PLG	Plant Products Co. Ltd.	www.plantprod.com	905-793-7000
SYZ	Syngenta Crop Protection	www.syngenta.ca	1-877-964-3682
TAO	Taminco Inc.	www.taminco.com	1-888-826-4680
TKI	Tessenderlo Kerley Inc.	www.tkinet.com	1-800-525-2803
TOA	Arysta LifeScience	www.arystalifescience.ca	1-866-761-9397
UAG	United Agri Products Canada Inc.	www.uap.ca	1-800-265-4624
UPI	United Phosphorus Inc.	www.upi-usa.com (U.S. website)	1-800-438-6071
VAA	Valent Biosciences	www.valent.com	1-800-682-5368
VAJ	Valent Canada Inc.	www.valent.ca	519-767-9262
VAR	Univar Canada Ltd.	www.univarcanada.com	1-800-265-7671

— = No information is available.

12. Appendices

APPENDIX A: Additional Resources for Ontario Fruit Growers

Many factsheets, publications and other resources are available from the Ontario Ministry of Agriculture and Food (OMAF).

These can be ordered from Service Ontario:

- Online at ServiceOntario Publications
www.publications.serviceontario.ca/ecom
- By phone through the ServiceOntario Contact Centre
Monday–Friday, 8:30 am–5:00 pm

416-326-5300

416-325-3408 (TTY)

1-800-668-9938 Toll-free across Canada

1-800-268-7095 TTY Toll-free across Ontario

- In person at ServiceOntario Centres located throughout the province or at any OMAF Resource Centre. Many can also be found online at
www.ontario.ca/omaf

For a complete list of publications from OMAF:
www.ontario.ca/omaf

Websites

Websites for technical information on pests in Ontario fruit crops:

- OMAF gateway to information on crops:
www.ontario.ca/crops
- Spotted wing drosophila:
www.ontario.ca/spottedwing
- Brown marmorated stink bug:
www.ontario.ca/stinkbug
- Crop IPM (integrated pest management) modules:
www.ontario.ca/croppipm

Label Search Tool to find labels for pesticides and products registered for use in Canada:
<http://pr-rp.lc-sc.gc.ca/lr-re/index-eng.php>

Information on pesticide application technology:
www.sprayers101.ca

Specialty Croppportunities to find information on specialty berries and fruit: www.ontario.ca/crops (search on “croppportunities”)

Resources on Application Technology

Ontario Pesticide Education Program:
www.oppep.ca

OMAF Factsheets:

- *How Weather Conditions Affect Spray Applications*
- *Six Elements of Effective Spraying in Orchards and Vineyards*
- *Calibrating Airblast Sprayers*
- *Adjusting, Maintaining and Cleaning Airblast Sprayers*
- *Pesticide Drift from Ground Applications*

Airblast 101 Course Materials: basic tools for applying pesticides and plant growth modifiers in an effective, economic and environmentally responsible manner. For more information, contact jason.deveau@ontario.ca

OMAF Publications

- *Agronomy Guide for Field Crops* – Publication 811
- *Growing Strawberries in Ontario* – Publication 513
- *Growing Red Raspberries in Ontario* – Publication 105
- *Guide to Fruit Production* – Publication 360
- *Guide to Weed Control* – Publication 75
- *Integrated Pest Management for Ontario Apples* – Publication 310
- *Ontario Field Vegetable Guide* – Publication 839 (expected release date of late 2014)
- *Soil Fertility Handbook* – Publication 611
- *Vegetable Crop Protection Guide* – Publication 838

Best Management Practices

The Best Management Practices series of publications presents a practical, affordable approach to conserving a farm's soil and water resources without sacrificing productivity.

A sampling of titles appears below. For a complete list of books in the BMP series, see: www.ontario.ca/omaf

- BMP01E *Farm Forestry and Habitat Management*
- BMP06E *Soil Management*
- BMP07E *Water Management*
- BMP08E *Irrigation Management*
- BMP09E *Integrated Pest Management*
- BMP13E *Pesticide Storage, Handling and Application*
- BMP15E *Buffer Strips*
- BMP16E *Manure Management*
- BMP20E *Managing Crop Nutrients*

APPENDIX B: Degree-Day Modeling

Temperature, light and moisture affect the growth and development of plants, disease-causing pathogens and pests. Of these, temperature is the most important factor for insect and mite development. These pests need a certain amount of heat to move to the next development stage. For pathogens, temperature and moisture play key roles in the development and infection of the plant.

The amount of heat required for insect, mite and pathogen development remains constant from year to year, but depending on weather conditions, the amount of actual time that it takes to complete development can vary. Insects, mites and pathogens have a minimum and maximum base temperature – below or above which development does not occur. These base temperatures are different for each organism.

Degree-Days Celsius (DDC) are used to estimate the growth and development of pests in the growing season (see Table 12-1. *Examples of Degree-Day Models Used in Fruit Crops*, page 292). Events such as egg-laying, egg hatch, movement of crawlers or the occurrence of disease infection can be predicted and used to schedule inspection and spray programs. For example, degree-day calculations can predict the first hatch of codling moth eggs or the percentage of apple scab ascospores that have matured in the orchard.

There are several methods used to calculate DDC, but the method commonly used with simple monitoring equipment is the averaging method or “max/min” method. DDC for a given organism are calculated as follows:

$$DDC = \frac{(\text{Daily max } ^\circ\text{C}) + (\text{Daily min } ^\circ\text{C})}{2} - \text{min base } ^\circ\text{C}$$

Degree-Days Celsius are accumulated daily. The averaging method works well in most years. However, the actual DDC accumulations may be underestimated in extended periods of cool weather or overestimated in hot weather.

An example of the averaging method on a relatively cool spring day:

For a given pest:

Lower base temperature = 10°C
Upper base temperature = 35°C

On a given day:

Minimum temperature = 5°C
Maximum temperature = 15°C
Degree-Days Celsius (DDC) for that day is = $(15 + 5)/2 - 10 = 0$

Note that the maximum temperature was higher than the base temperature for the insect, so growth and development were possible for at least part of the day. However, no DDC were accumulated. This illustrates how cool temperatures, especially over several days, could lead to an underestimation of insect development.

Degree-Days Celsius are either accumulated from a set start date, such as April 1, or from a specific event known as a biofix. A biofix is a biological event or indicator of a developmental event that initiates the beginning of DDC calculations. A common biofix used for insects is the first sustained catch in pheromone traps. Using a biofix provides predictions that are more accurate and requires tracking temperatures over a shorter period.

There are several limitations to degree-days models:

- Factors such as humidity, light intensity and rainfall also affect pest development. As a result, DDC predictions are only estimates of pest development. Verify these predictions with field observations.
- Temperatures used to determine DDC must represent the environment where organisms develop. Use weather data collected from within a mile or less of the actual orchard or field being monitored. Site-specific information can be obtained by using data loggers. Ventilated heat shields should be used with temperature-sensor data loggers to ensure accurate air temperatures. Place data loggers at locations in the crop where the pest is normally active.
- DDC models have been developed and validated for only a few fruit pests in Ontario.

DDC model calculators can be found on-line, such as <http://uspest.org/cgi-bin/ddmodel.us?app=std>

Keep in mind that many of these models have not been validated under Ontario conditions. Use precise temperature data measured on or very close to your farm for the best estimate of the development of these pests.

Table 12-1. Examples of Degree-Day Models Used in Fruit Crops

Pest	Base Temperature	Predicted Event		Model (when to expect the event)
Tarnished plant bug (strawberries)	12.1°C	1st nymphs in strawberries		• 30–40 DDC after April 1
Codling moth (apples)	10°C	1st egg hatch		• 139 DDC after first sustained moth catch (biofix)
Obliquebanded leafroller (apples)	6.1°C	1st egg hatch		• 220–244 DDC after first sustained moth catch (biofix)
Oriental fruit moth (peach)	7.2°C	1st generation	10% egg hatch	• 95 DDC after first sustained moth catch (biofix)
			55% egg hatch	• 195 DDC after first sustained moth catch (biofix)
			end of egg hatch	• 359 DDC after first sustained moth catch (biofix)
		2nd generation	10% egg hatch	• 639 DDC after first sustained moth catch (biofix)
			55% egg hatch	• 780 DDC after first sustained moth catch (biofix)
			end of egg hatch	• 1,083 DDC after first sustained moth catch (biofix)
		3rd generation	10% egg hatch	• 1,167 DDC after first sustained moth catch (biofix)
			55% egg hatch	• 1,375 DDC after first sustained moth catch (biofix)
			end of egg hatch	• 1,765 DDC after first sustained moth catch (biofix)
Grape berry moth ¹	8.3°C	1st generation	1st egg hatch	• 450 DDC after 50% bloom on wild grapes
		2nd generation	1st egg hatch	• 900 DDC after 50% bloom on wild grapes
		3rd generation	1st egg hatch	• 1,350 DDC after 50% bloom on wild grapes
Spotted wing drosophila ²	10°C	overwintering generation	peak egg laying by overwintering females and 1st adult emergence	• 283 DDC after Jan 1
		1st generation	peak adult emergence	• 419 DDC after Jan 1
		2nd generation	peak adult emergence	• 694 DDC after Jan 1
		3rd generation	peak adult emergence	• 968 DDC after Jan 1
		4th generation	peak adult emergence	• 1243 DDC after Jan 1
Apple scab ³	0°C	high risk of primary infections	rapid maturation of ascospores	• 125 DDC after bud break on McIntosh
		end of the primary infection period	95% of the ascospores should be depleted if sufficient rainfall has occurred	• 418 DDC after bud break on McIntosh

¹ Tobin, P.C., Nagarkatti, S. and Saunders, M.C. 2001. Modeling development in grape berry moth (Lepidoptera: Tortricidae). *Environmental Entomology* 30(4):692–699.² Coop, L. and Dreves, A.J. 2013. Predicting when spotted wing drosophila begins activity using a degree-day model. Oregon State University. Retrieved online at http://whatcom.wsu.edu/ipm/swd/documents/Article_DDModel.pdf.³ Gadoury, D.M. and MacHardy, W.E. 1982. A model to estimate the maturity of ascospore of *Venturia inaequalis*. *Phytopathology* 72:901–904.

APPENDIX C: Crop Groupings for Pesticide Registrations in Canada

To facilitate the establishment of Maximum Residue Limits (MRLs), the Pest Management Regulatory Agency (PMRA) uses crop groups. Individual crops are allocated to a crop group based on botanical and taxonomic criteria, as well as cultivation practices. Crop groups simplify the establishment of MRLs by using residue data for crops that are representative of the whole group to extend to all crops within the crop group. Crop groups can also contain smaller and more closely related crop subgroups.

Many new registrations apply to entire crop groups, providing pest control options for new or minor crops not listed in the pest control calendars in this publication. These are listed in below. Products with crop group registrations are indicated in Table 11-5. *Pesticides Used on Fruit Crops in Ontario*, page 277.

CROP GROUP 11: Pome Fruits Group

Representative commodities: apple and pear.

- Apple
- Crabapple
- Loquat
- Mayhaw
- Pear
- Pear, oriental
- Quince

CROP GROUP 11-09: Pome Fruits Group

Representative commodities: apple and pear.

- Apple
- Azarole
- Crabapple
- Loquat
- Mayhaw
- Medlar
- Pear
- Pear, Asian
- Quince
- Quince, Chinese
- Quince, Japanese
- Tejocote
- Cultivars, varieties and/or hybrids of these

CROP GROUP 12: Stone Fruits Group

Representative commodities: sweet cherry or sour cherry, peach, and plum or fresh prune.

- Apricot
- Cherry, sweet
- Cherry, sour
- Nectarine
- Peach
- Plum
- Plum, Chickasaw
- Plum, Damson
- Plum, Japanese
- Plumcot
- Prune (fresh)

CROP GROUP 12-09: Stone Fruits Group

Representative commodities: sweet or sour cherry, peach, and plum or prune plum.

- | | |
|---------------------|--|
| • Apricot | • Plum, beach |
| • Apricot, Japanese | • Plum, Canada |
| • Capulin | • Plum, cherry |
| • Cherry, black | • Plum, Chickasaw |
| • Cherry, Nanking | • Plum, Damson |
| • Cherry, sweet | • Plum, Japanese |
| • Cherry, sour | • Plum, Klamath |
| • Chokecherry | • Plum, prune |
| • Nectarine | • Plumcot |
| • Peach | • Sloe |
| • Plum | • Cultivars, varieties, and hybrids of these |
| • Plum, American | |

CROP SUBGROUP 12-09A: Cherry subgroup

Representative commodities: sweet or sour cherry.

- Capulin
- Cherry, black
- Cherry, Nanking
- Chokecherry
- Cherry, sweet
- Cherry, sour
- Cultivars, varieties, and hybrids of these

CROP SUBGROUP 12-09B: Peach subgroup

Representative commodities: peach.

- Nectarine
- Peach
- Cultivars, varieties, and hybrids of these

CROP SUBGROUP 12-09C: Plum subgroup

Representative commodities: plum or prune plum.

- Apricot
- Apricot, Japanese
- Plum
- Plum, American
- Plum, beach
- Plum, Canada
- Plum, cherry
- Plum, Chickasaw
- Plum, Damson
- Plum, Japanese
- Plum, Klamath
- Plum, prune
- Plumcot
- Sloe
- Cultivars, varieties, and hybrids of these

CROP GROUP 13: Berries Group

Representative commodities: blackberry or raspberry, and blueberry.

- Blackberry
- Blueberry
- Currant
- Elderberry
- Gooseberry
- Huckleberry
- Loganberry
- Raspberry, black and red

CROP SUBGROUP 13A: Caneberry subgroup

Representative commodity: blackberry or raspberry.

- Blackberry
- Loganberry
- Raspberry, black and red

CROP SUBGROUP 13B: Bushberry subgroup

Representative commodity: highbush blueberry.

- Blueberry
- Currant
- Elderberry
- Gooseberry
- Huckleberry

CROP GROUP 13-07: Berry and Small Fruit Crop Group

Representative commodities: blackberry or raspberry, highbush blueberry, elderberry or mulberry, grape, strawberry, and fuzzy kiwifruit.

- | | |
|----------------------------|--|
| • Blackberry | • Honeysuckle, edible |
| • Blueberry, highbush | • Jostaberry |
| • Blueberry, lowbush | • June (Saskatoon) berry |
| • Currant, black | • Kiwifruit, fuzzy |
| • Currant, red | • Kiwifruit, hardy |
| • Elderberry | • Lingonberry |
| • Gooseberry | • Maypop |
| • Huckleberry | • Mountain pepper berries |
| • Raspberry, black and red | • Mulberry |
| • Amur river grape | • Muntries |
| • Aronia berry | • Native currant |
| • Bayberry | • Partridgeberry |
| • Bearberry | • Phalsa |
| • Bilberry | • Pincherry |
| • Buffalo currant | • Riberry |
| • Buffaloberry | • Salal |
| • Che | • Schisandra berry |
| • Chilean guava | • Sea buckthorn |
| • Chokecherry | • Serviceberry |
| • Cloudberry | • Strawberry |
| • Cranberry | • Wild raspberry |
| • European barberry | • Cultivars, varieties and/or hybrids of these |
| • Grape | |
| • Highbush cranberry | |

CROP SUBGROUP 13-07A: Caneberry subgroup

Representative commodities: blackberry or raspberry.

- Blackberry
- Loganberry
- Raspberry, black and red
- Wild raspberry
- Cultivars, varieties and/or hybrids of these

CROP SUBGROUP 13-07B: Bushberry subgroup

Representative commodity: highbush blueberry.

- | | |
|-----------------------|--|
| • Blueberry, highbush | • Highbush cranberry |
| • Blueberry, lowbush | • Honeysuckle, edible |
| • Currant, black | • Jostaberry |
| • Currant, red | • June (saskatoon) berry |
| • Elderberry | • Lingonberry |
| • Gooseberry | • Native currant |
| • Huckleberry | • Salal |
| • Aronia berry | • Sea buckthorn |
| • Buffalo currant | • Cultivars, varieties and/or hybrids of these |
| • Chilean guava | |
| • European barberry | |

CROP SUBGROUP 13-07C: Large Shrub/Tree Berry subgroup

Representative commodities: elderberry or mulberry.

- Elderberry
- Bayberry
- Buffaloberry
- Che
- Chokecherry
- June (saskatoon) berry
- Mountain pepper berries
- Mulberry
- Phalsa
- Pincherry
- Riberry
- Salal
- Serviceberry
- Cultivars, varieties and/or hybrids of these

Source: Health Canada, *Regulatory Directive DIR98-02* and its revisions.

CROP SUBGROUP 13-07D: Small Fruit Vine Climbing subgroup

Representative commodities: grape and fuzzy kiwifruit.

- Gooseberry
- Amur river grape
- Grape
- Kiwifruit, fuzzy
- Kiwifruit, hardy
- Maypop
- Schisandra berry
- Cultivars, varieties and/or hybrids of these

CROP SUBGROUP 13-07E: Small Fruit Vine Climbing subgroup, except Grape

Representative commodity: fuzzy kiwifruit.

- Gooseberry
- Amur river grape
- Kiwifruit, fuzzy
- Kiwifruit, hardy
- Maypop
- Schisandra berry
- Cultivars, varieties and/or hybrids of these

CROP SUBGROUP 13-07F: Small Fruit Vine Climbing subgroup, except Fuzzy Kiwifruit

Representative commodity: grape.

- Gooseberry
- Amur river grape
- Grape
- Kiwifruit, hardy
- Maypop
- Schisandra berry
- Cultivars, varieties and/or hybrids of these

CROP SUBGROUP 13-07G: Low Growing Berry subgroup

Representative commodity: strawberry.

- Blueberry, lowbush
- Bearberry
- Bilberry
- Cloudberry
- Cranberry
- Lingonberry
- Muntries
- Partridgeberry
- Strawberry
- Cultivars, varieties and/or hybrids of these

CROP SUBGROUP 13-07H: Low Growing Berry subgroup, except Strawberry

Representative commodity: cranberry.

- Blueberry, lowbush
- Bearberry
- Bilberry
- Cloudberry
- Cranberry
- Lingonberry
- Muntries
- Partridgeberry
- Cultivars, varieties and/or hybrids of these

CROP GROUP 14: Tree Nuts Group

Representative commodities: almond and pecan.

- Almond
- Beech Nut
- Brazil Nut
- Butternut
- Cashew
- Chestnut
- Chinquapin
- Filbert (hazelnut)
- Hickory nut
- Macadamia nut (bush nut)
- Pecan
- Walnut, black
- Walnut, English

CROP GROUP 14-11: Tree Nuts Crop Group

Representative commodities: almond and pecan.

- African nut tree
- Almond
- Beechnut
- Brazil nut
- Brazilian pine
- Bunya
- Bur Oak
- Butternut
- Cajou
- Candlenut
- Cashew
- Chestnut
- Chinquapin
- Coconut
- Coquito nut
- Dika nut
- Ginkgo
- Guiana chestnut
- Hazelnut (Filbert)
- Hearnut
- Hickory nut
- Japanese horse-chestnut
- Macadamia nut
- Mongongo nut
- Monkey-pot
- Monkey puzzle nut
- Okari nut
- Pachira nut
- Peach palm nut
- Pecan
- Pequi
- Pili nut
- Pine nut
- Pistachio
- Sapucaia nut
- Tropical almond
- Walnut, black
- Walnut, English
- Yellowhorn
- Cultivars, varieties, and/or hybrids of these

Source: Health Canada, *Regulatory Directive DIR98-02* and its revisions.

APPENDIX D: Suppliers of Pest Monitoring Equipment and Biological Control Agents

This list includes sources of weather monitoring equipment, pest monitoring supplies and biological control agents. For a more extensive list of beneficial insects and mite suppliers, see the OMAF website at www.ontario.ca/crops. This is a partial list and does not imply endorsement or recommendation by the Ontario Ministry of Agriculture and Food of the companies listed.

Company	Address	Telephone/Fax/Email	Products
Biobest Canada Ltd. www.biobest.ca	2020 Foxrun Rd. R.R. #4 Leamington, ON N8H 3V7	Tel: 519-322-2178 Fax: 519-322-1271 Email: info@biobest.ca	• beneficial insects, mites, nematodes • insect traps and pheromones • bumblebee hives for pollination
Contech Enterprises Inc. www.contech-inc.com	7572 Progress Way Delta, BC V4G 1E9	Tel: 604-940-9944 Toll-free: 1-800-767-8658 Fax: 604-940-9433 Email: sales@contech-inc.com	• pheromone lures and traps
Cooper Mill Ltd. www.coopermill.com	31 Hastings Road R.R. #3 Madoc, ON K0K 2K0	Tel: 613-473-4847 Fax: 613-473-5080 Email: ipm@coopermill.com	• pheromone lures and traps
Gempler's www.gemplers.com	P.O. Box 44993 Madison, WI USA 53744	Tel: 1-800-382-8473 Fax: 1-800-551-1128 Email: customerservice@gempler.com	• weather monitoring equipment • pheromone lures and traps • tangle traps • magnifiers • tally counters
Great Lakes IPM, Inc. www.greatlakesipm.com	10220 Church Road NE Vestaburg, MI USA 48891	Tel: 989-268-5693 Toll-free: 1-800-235-0285 Fax: 989-268-5311 Email: glipm@greatlakesipm.com	• apple scab monitoring equipment • pheromone lures and traps • tangle traps • magnifiers • tally counters • insect sweep nets • field diagnostic equipment
Koppert Canada Ltd. www.koppertonline.ca	50 Ironside Cres. #2 Scarborough, ON M1X 1G4	Tel: 1-800-567-4195 Fax: 416-291-0902 Email: info@koppert.ca	• beneficial insects, mites • insect traps • BioWorks products
MGS Horticultural Inc. www.mgshort.com	50 Hazelton Street Leamington, ON N8H 1B8	Tel: 519-326-9037 Fax: 519-326-9290 Email: info@mgshort.com	• pheromone lures and traps • mating disruption devices • rodent traps • sticky tape and cards • beneficial insects
Natural Insect Control www.naturalinsectcontrol.com	3737 Netherby Rd. Stevensville, ON L0S 1S0	Tel: 905-382-2904 Fax: 905-382-4418 Email: nic@niagara.com	• beneficial insects, mites and nematodes (Canadian strains) • pheromone lures and traps • mating disruption devices • bird houses
N.M. Bartlett Inc. www.bartlett.ca	4509 Bartlett Rd. Beamsville, ON L0R 1B1	Tel: 905-563-8261 Toll-free: 1-800-767-8658 Fax: 905-563-7882 Email: info@bartlett.ca	• pheromone lures and traps • mating disruption devices
PheroTech www.pherotech.com	7572 Progress Way Delta, BC V4G 1E9	Tel: 604-940-9944 Fax: 604-940-9433 Email: sales@pherotech.com	• pheromone lures and traps
Solida Distributors www.solida.ca	480 rue St-Antoine St. Ferreol-Ies-Neiges, QC G0A 3R0	Tel: 418-826-0900 Fax: 418-826-0901 Email: info@solida.ca	• pheromone traps and lures • tangle traps, insect trap coating • hand lens magnifiers • tally counters • product technical support
Warwick Orchards and Nursery	7056 Egremont Rd. R.R. #8 Watford, ON N0M 2S0	Tel: 519-849-6730 Fax: 519-849-6731 Email: warwickorchards@brktel.on.ca	• DeWitt leaf wetness sensor

APPENDIX E: Safety Supply Companies

This is a list of safety supply companies in Ontario providing protective clothing and personal protective equipment. Ask safety supply companies for help to select protective clothing and personal protective equipment. This is a partial list and does not imply endorsement or recommendation by the Ontario Ministry of Agriculture and Food of the companies listed.

Company	Address	Telephone/Fax/Email	
3-M Canada Company Occupational Health and Environmental Safety	300 Tartan Drive London, ON N5V 4M9	Toll-free: 1-800-364-3577 Toll-free fax: 1-800-603-7758	
www.3m.ca			
Acklands Grainger	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	Tel: 905-731-5516 Toll-free: 1-866-248-8801 Fax: 905-731-2798 Email: contact@agi.ca	
www.acklandsgrainger.com			
Dupont Personal Protection	Box 2200 Streetsville Mississauga, ON L5M 2H3	Tel: 905-821-3300 Toll-free: 1-800-387-9326 Fax: 905-821-5110 Toll-free fax: 1-866-765-5357	
www.personalprotection.dupont.com			
Dutch Industries "Protect-Air Cab Filter"	Huron Tractor 305 Main Street N. Exeter, ON N0M 1S3	Tel: 519-235-1115 Fax: 519-235-1939	
www.dutchopeners.com www.hurontractor.com			
Hamisco	3392 Wonderland Rd. S. London, ON N6L 1A8	Tel: 519-652-9800 Toll-free: 1-800-668-9800 Fax: 519-652-966	
www.hamisco.com			
Levitt-Safety (Eastern) Ltd.	2872 Bristol Circle Oakville, ON L6H 5T5	Tel: 905-829-3299 Toll-free: 1-888-453-8488 Fax: 905-829-2919	
www.levitt-safety.com			
Mitt & Robe Co. Ltd.	751 Norfolk St. N. Simcoe, ON N3Y 3R6	Tel: 519-428-4050 Toll-free: 1-877-893-6565 Fax: 519-428-5142 Email: sales@mittrobe.ca	
www.mittrobe.ca			
MSA Canada	222-5535 Eglinton Ave. W. Toronto, ON M9C 5K5	Tel: 416-620-4225 Toll-free: 1-800-MSA-2222 Fax: 905-238-4151	
www.msanet.com			
Plant Products Co. Ltd.	314 Orenda Rd. Brampton, ON L6T 1G1	Tel: 905-793-7000 Toll-free: 1-800-387-2449 Fax: 905-793-9157	
www.plantprod.com			
Safety Express	4190 Sladeview Cres. Unit 1 and 2 Mississauga, ON L5L 0A1	Tel: 905-608-0111 Toll-free: 1-800-465-3898 Fax: 905-608-0091 Email: info@safetyexpress.com	
www.safetyexpress.com			
The St. George Company (suppliers of Kasco Helmets)	20 Consolidated Dr. P.O. Box 430 Paris, ON N3L 3T5	Tel: 519-442-2046 Toll-free: 1-800-461-4299 Fax: 519-442-7191 Email: sales@thestgeorgeco.com	
www.thestgeorgeco.com			

APPENDIX F: Accredited Soil-Testing Laboratories in Ontario

The following labs are accredited to perform soil tests for pH, buffer pH, potassium, phosphorus, magnesium and nitrate-nitrogen on Ontario soils.

Laboratory Name	Address	Telephone/Fax/Email		Contact
A & L Canada Laboratories Inc. www.alcanada.com	2136 Jetstream Rd. London, ON N5V 3P5	Tel: 519-457-2575 Fax: 519-457-2664 Email: alcanadalabs@alcanada.com		Greg Patterson Ian McLachlin
Activation Laboratories Ltd. www.actlabsag.com	9-1480 Sandhill Dr. Ancaster, ON L9G 4V5	Tel: 289-204-0515 ext. 102/104 Fax: 289.204.0514 Email: Laboratory@ActLabsAg.com		Rob Deakin Dr. Steve Jenkins
SGS Agri-Food Laboratories www.agtest.co	503 Imperial Rd. Unit #1 Guelph, ON N1H 6T9	Tel: 519-837-1600 Toll-free: 1-800-265-7175 Fax: 519-837-1242 Email: lab@agtest.com		Jack Legg Papken Bedirian
Brookside Laboratories, Inc. www.blinc.com	200 White Mountain Dr. New Bremen, OH USA 45869	Tel: 419-977-2766 Fax: 419-977-2767 Email: jbrackman@blinc.com		Jackie Brackman Mark Flock
Exova Accutest Laboratory Exova Canada Inc. www.exova.com	8-146 Colonnade Rd. Ottawa, ON K2E 7Y1	Tel: 613-727-5692, ext. 317 Fax: 613-727-5222 Email: lorna.wilson@exova.com		Lorna Wilson
FoReST Laboratory http://lucas.lakeheadu.ca/forest	955 Oliver Rd. BB1005D Thunder Bay, ON P7B 5E1	Tel: 807-343-8639 Fax: 807-343-8116 Email: soilslab@lakeheadu.ca		Claire Riddell Joel Symonds
University of Guelph Laboratory Services www.labservices.uoguelph.ca/units/soil-nutrient	University of Guelph P.O. Box 3650, 95 Stone Rd. W. Guelph, ON N1H 8J7	Tel: 519-767-6299 Fax: 519-767-6240 Email: affinfo@uoguelph.ca		Nick Schrier
Stratford Agri Analysis www.stratfordagri.ca	1131 Erie St. Box 760 Stratford, ON N5A 6W1	Tel: 519-273-4411 1-800-323-9089 Fax: 519-273-2163 Email: info@stratfordagri.ca		Keith Lemp Mark Aikman

There is no official accreditation in Ontario for tissue analysis but all the accredited soil-testing labs are monitored for proficiency on tissue analyses.

APPENDIX G: Diagnostic Services

Samples for disease diagnosis, insect or weed identification, nematode counts and *Verticillium* testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Rd. W.
Guelph, ON N1H 8J7
Tel: 519-767-6299
Fax: 519-767-6240
Website: www.guelphlabservices.ca
Email: afinfo@uoguelph.ca

Payment must accompany samples at the time of submission. Submission forms are available at www.guelphlabservices.com/AFL/submit_samples.aspx

To obtain information on the fee schedule, visit www.uoguelph.ca/pdc or phone the Pest Diagnostic Clinic.

How to Sample for Nematodes

Soil

When to sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June, and again in September and October.

How to sample soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 in.). If the soil is bare, remove the top 2 cm (1 in.) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well, then take a sample of ½–1 L (1 pint–1 qt) from this. No single sample should represent more than 2.5 ha (6.25 ac). Mix subsamples in a clean pail or plastic bag.

Sampling pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

Number of subsamples

Based on the total area sampled:

500 m ² (5,400 ft ²)	10 subsamples
500 m ² –0.5 ha (5,400 ft ² –1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g (½–1 oz.), dig fresh weight from the feeder root zone and submit.

Problem areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

Sample handling

Soil samples

Place in plastic bags as soon as possible after collecting.

Root samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5–10°C (40–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). Only living nematodes can be counted. Accurate counts depend on proper handling of samples.

Submitting Plant for Disease Diagnosis or Identification

Sample submission forms

Forms can be obtained from your local Ontario Ministry of Agriculture and Food office. Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past three years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. If symptoms are general, collect the sample from an area where they are of intermediate severity. Completely dead material is usually inadequate for diagnosis.

With plant specimens submitted for identification, include at least a 20–25 cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in

identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying out and contamination of the leaves by soil. Do not add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first-class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting samples

Place dead, hard-bodied insects in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.

APPENDIX H: Ontario Ministry of Agriculture and Food – Fruit Crop Advisory Staff

Agroforestry Specialist	Todd Leuty	Tel: 519-826-3215	todd.leuty@ontario.ca
Apple Specialist	Leslie Huffman	Tel: 519-738-1256	leslie.huffman@ontario.ca
Application Technology Specialist	Jason Deveau	Tel: 519-426-8934	jason.deveau@ontario.ca
Berry Crop Specialist	Pam Fisher	Tel: 519-426-2238	pam.fisher@ontario.ca
Crop Protection Program Lead	Denise Beaton	Tel: 519-826-6594	denise.beaton@ontario.ca
Entomology, Horticulture Program Lead	Hannah Fraser	Tel: 905-562-1674	hannah.fraser@ontario.ca
Fresh Market Quality Program Lead	Jennifer R. DeEll	Tel: 519-426-1408	jennifer.deell@ontario.ca
IPM Specialist – Specialty Crops	Melanie Filotas	Tel: 519-426-4434	melanie.filotas@ontario.ca
IPM Systems Specialist	Margaret Appleby	Tel: 613-475-5850	margaret.appleby@ontario.ca
Minor Use Coordinator	Jim Chaput	Tel: 519-826-3539	jim.chaput@ontario.ca
New Crop Development Specialist	Evan Elford	Tel: 519-426-4509	evan.elford@ontario.ca
Nutrient Management Horticulture Program Lead	Deanna Nemeth	Tel: 905-562-1170	deanna.nemeth@ontario.ca
Nutrition – Horticulture Program Lead	Christoph Kessel	Tel: 519-824-4120 ext. 52480	christoph.kessel@ontario.ca
Pathologist – Horticulture Program Lead	Michael Celetti	Tel: 519-824-4120 ext. 58910	michael.celetti@ontario.ca
Pome Fruit IPM Specialist	Kristy Grigg-McGuffin	Tel: 519-426-4322	kristy.grigg-mcguffin@ontario.ca
Soil Management Specialist	Anne Verhallen	Tel: 519-674-1614	anne.verhallen@ontario.ca
Tender Fruit and Grape IPM Specialist	Wendy McFadden-Smith	Tel: 905-562-3833	wendy.mcfadden-smith@ontario.ca
Tender Fruit and Grape Specialist	Kathryn Carter	Tel: 905-562-1639	kathryn.carter@ontario.ca
Transition Crop Specialist	Jim Todd	Tel: 519-426-3823	jim.todd@ontario.ca
Weed Management Program Lead – Horticulture	Kristen Obeid	Tel: 519-738-1232	kristen.obeid@ontario.ca

A complete list of Ontario Ministry of Agriculture and Food advisory staff is available on the OMAF website at www.ontario.ca/crops.

Agricultural Information Contact Centre

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

1 Stone Rd. W., Guelph, ON N1G 4Y2
Tel: 1-877-424-1300 Fax: 519-826-3442
Email: ag.info.omaf@ontario.ca

APPENDIX I: Ontario Ministry of the Environment – Regional Contact Information

Region/County	Address	Telephone/Fax
Central Region Toronto, Halton, Peel, York, Durham, Muskoka, Simcoe	5775 Yonge St., 8th Floor Toronto, ON M2M 4J1	Tel: 416-326-6700 Toll-free: 1-800-810-8048 Fax: 416-325-6345
West-Central Region Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King St. W., 12th Floor Hamilton, ON L8P 4Y7	Tel: 905-521-7640 Toll-free: 1-800-668-4557 Fax: 905-521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Haliburton, Peterborough, Kawartha Lakes, Northumberland, Renfrew, Ottawa, Lanark, District of Nipissing (Twp. of South Algonquin)	1259 Gardiners Rd., Unit 3 PO Box 22032 Kingston, ON K7M 8S5	Tel: 613-549-4000 Toll-free: 1-800-267-0974 Fax: 613-548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth	733 Exeter Rd. London, ON N6E 1L3	Tel: 519-873-5000 Toll-free: 1-800-265-7672 Fax: 519-873-5020
Northern Region (East) Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma (East), Timiskaming, Sault Ste. Marie	199 Larch St., Ste. 1201 Sudbury, ON P3E 5P9	Tel: 705-564-3237 Toll-free: 1-800-890-8516 Fax: 705-564-4180
Northern Region (West) Algoma (West), Cochrane, Kenora, Rainy River, Timmins, Thunder Bay	435 James St. S., Ste. 331 Thunder Bay, ON P7E 6S7	Tel: 807-475-1205 Toll-free: 1-800-875-7772 Fax: 807-475-1745
Standards Development Branch	Pesticides Section 40 St. Clair Ave. W. 7th Floor Toronto, ON M4V 1L5	Tel: 416-327-5519 Fax: 416-327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Ave. W. 12A Floor Toronto, ON M4V 1L5	Tel: 416-314-8001 Toll-free: 1-800-461-6290 Fax: 416-314-8452

APPENDIX J: Other Contacts

Agriculture and Agri-Food Canada Research Centres

www.agr.gc.ca/index_e.php

Eastern Cereals and Oilseeds Research Centre

960 Carling Ave.
Ottawa, ON K1A 0C6
Tel: 613-759-1858

Greenhouse and Processing Crops Centre

2585 County Road 20
Harrow, ON N0R 1G0
Tel: 519-738-2251

Southern Crop Protection and Food Research Centre

1391 Sandford St.
London, ON N5V 4T3
Tel: 519-457-1470

Vineland Research Farm

4902 Victoria Ave. N.
Vineland, ON L0R 2E0
Tel: 905-562-4113

Canadian Food Inspection Agency Regional Offices (Plant Protection)

www.inspection.gc.ca

Belleville

345 College St. E.
Belleville, ON K8N 5S7
Tel: 613-969-3333

Brantford

625 Park Rd. N., Suite 6
Brantford, ON N3T 5P9
Tel: 519-753-3478

Hamilton

709 Main St. W., Ste. 101
Hamilton, ON L8S 1A2
Tel: 905-572-2201

London

19-100 Commissioners Rd. E.
London, ON N5Z 4R3
Tel: 519-691-1300

St. Catharines

395 Ontario St., PO Box 19
St. Catharines, ON L2N 7N6
Tel: 905-937-8232

Ottawa District

38 Auriga Dr., Unit 8
Ottawa, ON K2E 8A5
Tel: 613-274-7374, ext. 221

Toronto

1124 Finch Ave. W., Unit 2
Downsview, ON M3J 2E2
Tel: 416-665-5055

University of Guelph

Main Campus

Guelph, ON N1G 2W1
Tel: 519-824-4120
www.uoguelph.ca

Alfred Campus

Alfred, ON K0B 1A0
Tel: 613-679-2218
Fax: 613-679-2423
www.alfredc.uoguelph.ca

Kemptville Campus

Kemptville, ON K0G 1J0
Tel: 613-258-8336
Fax: 613-258-8384
www.kemptvillec.uoguelph.ca

Ridgetown Campus

Ridgetown, ON N0P 2C0
Tel: 519-674-1500
www.ridgetownc.uoguelph.ca

Department of Plant Agriculture

www.plant.uoguelph.ca

Department of Plant Agriculture, Guelph

50 Stone Rd. W.
Guelph, ON N1G 2W1
Tel: 519-824-4120, ext. 56083
Fax: 519-763-8933

Department of Plant Agriculture, Simcoe

1283 Blueline Road, PO Box 587
Simcoe, ON N3Y 4N5
Tel: 519-426-7127
Fax: 519-426-1225

Department of Plant Agriculture, Vineland

4890 Victoria Ave. N., PO Box 7000
Vineland Station, ON L0R 2E0
Tel: 905-562-4141
Fax: 905-562-3413

Lab Services Division

95 Stone Rd. W., PO Box 3650
Guelph, ON N1H 8J7
Tel: 519-767-6299
www.uoguelph.ca/labserv

Trace Organics and Pesticides

Tel: 519-767-6485

Pest Diagnostic Clinic

Tel: 519-767-6256

Vineland Research and Innovation Centre

4890 Victoria Ave. N.
Vineland Station, ON L0R 2E0
Tel: 905-562-0320
Fax: 905-562-0084
www.vinelandresearch.com

APPENDIX K: Production Insurance

Production Insurance (PI) covers production losses and yield reductions caused by insured perils. This includes adverse weather, disease, wildlife and insect infestations. Depending on the plan, coverage is available on a total-yield, dollar-value or acreage-loss basis. Producers can choose the type and level of coverage that best meets their needs. When enrolled in PI, producers are guaranteed a level of production, based on their yield history and their chosen coverage level. Claims are paid when an insured peril causes a yield to fall below the guaranteed production.

In Ontario, Agricorp administers PI on behalf of the Government of Ontario and Agriculture and Agri-Food Canada. More than 16,000 producers and 2 million hectares (5 million acres) of Ontario farmland are insured each year.

Production Insurance is part of programming available under the federal-provincial-territorial initiative Growing Forward 2. In most plans, producers pay 40% of the total premium cost and none of the administration cost. Together, the federal and provincial governments contribute the other 60%. Administrative costs are fully funded by both levels of government.

PI is available to all Ontario farmers, landlords and sharecroppers who grow an eligible crop. Coverage is available on approximately 90 commercially grown crops in Ontario in the following sectors:

- forage
- fresh vegetables
- fruit
- grains and oilseeds
- processing vegetables
- specialty crops

For more information, contact Agricorp.

Agricorp

1 Stone Rd. W.
Box 3660, Stn. Central
Guelph, ON N1H 8M4
Open weekdays, 7 am – 5 pm
Tel: 1-888-247-4999
TTY: 1-877-275-1380
Fax: 519-826-4118
Email: contact@agricorp.com
Web: www.agricorp.com

Ontario Crops Covered by Production Insurance (as of May 28, 2013)

General Crops

- buckwheat
- canola
- coloured beans (black, cranberry, kidney, Japanese/other)
- corn (conventional, organic options)
- flax
- forage (excess and insufficient options)
- mustard
- new forage seeding (premium and standard)
- peanuts
- popping corn
- rye
- soybeans (conventional, tofu, natto and organic options available)
- spring grain
- seed corn
- sorghum
- spring wheat
- sugar beets
- sunflower
- triticale
- white beans
- winter spelt, organic
- winter wheat (soft white, hard white, soft red, hard red, organic options)

Specialty Crops

- industrial hemp
- honey
- tobacco (black, burley, flue-cured)

Fruit Crops

- apples and apple trees
- cherries (sweet, sour)
- grapes and grape vines
- peaches/nectarines
- pears
- plums
- strawberries

Vegetable Crops – average farm yield or total production

- asparagus
- broccoli
- green beans and wax beans (processing)
- butternut squash (processing)
- cabbages
- carrots (fresh)
- carrots (processing)
- cauliflower
- celery
- cucumbers (processing)
- lettuce
- lima beans (processing)
- onions (seed, set, Spanish, yellow)
- parsnips
- peas (processing)
- peppers (banana, bell)
- potatoes (fresh)
- potatoes (processing)
- red beets (processing)
- rutabagas
- sweet corn (fresh)
- sweet corn (processing)
- tomatoes (fresh)
- tomatoes (processing)

Fresh Market Vegetables – acreage loss**Root vegetables**

- carrots
- celeriac
- French shallots
- garlic
- green onions
- leeks
- parsnips
- radishes
- red beets
- rutabagas
- Spanish onions
- sweet potatoes
- turnips
- yellow onions

Leafy vegetables

- broccoli
- Brussels sprouts
- cauliflower
- celery
- Chinese cabbage
- kale
- lettuce
- mesclun
- spinach
- summer cabbage
- winter cabbage

Fruit vegetables

- cucumbers
- eggplant
- melons
- bell and specialty peppers
- pumpkins
- squash
- tomatoes
- watermelon
- zucchini

Other vegetables

- broad beans
- green and wax beans
- green peas
- sweet corn

APPENDIX L: The Metric System**Metric Units****Linear Measures (length)**

10 millimetres (mm)	=	1 centimetre (cm)
100 centimetres (cm)	=	1 metre (m)
1,000 metres	=	1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m ²	=	1 hectare (ha)
100 ha	=	1 square kilometre (km ²)

Cubic Measures (volume)**Dry Measure**

1,000 cubic millimetres (mm ³)	=	1 cubic centimetre (cm ³)
1,000,000 cm ³	=	1 cubic metre (m ³)

Liquid Measure

1,000 millilitres (mL)	=	1 litre (L)
100 L	=	1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1,000 grams	=	1 litre (1.00 L)
(0.5 kg) 500 g	=	500 mL (0.5 L)
(0.1 kg) 100 g	=	100 mL (0.1 L)
(0.01 kg) 10 g	=	10 mL (0.01 L)
(0.001 kg) 1 g	=	1 mL (0.001 L)

Weight Measures

1,000 milligrams (mg)	=	1 gram (g)
1,000 g	=	1 kilogram (kg)
1,000 kg	=	1 tonne (t)
1 mg/kg	=	1 part per million (ppm)

Dry-Liquid Equivalents

1 cm ³	=	1 mL
1 m ³	=	1,000 L

Approximate Metric Conversions

5 mL	=	1 tsp
15 mL	=	1 tbsp
28.5 mL	=	1 Imp. fl. oz.

Application Rate Conversions**Metric to Imperial or U.S. (approximate)**

litres per hectare x 0.09	=	Imp. gallons per acre
litres per hectare x 0.11	=	U.S. gallons per acre
litres per hectare x 0.36	=	Imp. quarts per acre
litres per hectare x 0.43	=	U.S. quarts per acre
litres per hectare x 0.71	=	Imp. pints per acre
litres per hectare x 0.86	=	U.S. pints per acre
millilitres per hectare x 0.014	=	U.S. fluid ounces per acre
grams per hectare x 0.014	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial or U.S. to Metric (approximate)

Imp. gallons per acre x 11.23	=	litres per hectare (L/ha)
U.S. gallons per acre x 9.35	=	litres per hectare (L/ha)
Imp. quarts per acre x 2.8	=	litres per hectare (L/ha)
U.S. quarts per acre x 2.34	=	litres per hectare (L/ha)
Imp. pints per acre x 1.4	=	litres per hectare (L/ha)
U.S. pints per acre x 1.17	=	litres per hectare (L/ha)
Imp. fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
U.S. fluid ounces per acre x 73	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
pounds per acre x 0.45	=	kilograms per acre (kg/acre)
ounces per acre x 70	=	grams per hectare (g/ha)

Liquid Equivalents

Litres/Hectare	Approximate Gallons/Acre	
	Imperial Gallons	U.S. Gallons
50	= 4.45	5.35
100	= 8.9	10.7
150	= 13.53	16.05
200	= 17.8	21.4
250	= 22.25	26.75
300	= 26.7	32.1

Application Rate Conversions (cont'd)**Approximate Dry Weight Equivalents**

Grams/Hectare	Ounces/Acre
100	= 1 ½
200	= 3
300	= 4 ¼
500	= 7
700	= 10
Kilograms/Hectare	Pounds/Acre
1.10	= 1
1.50	= 1 ¼
2.00	= 1 ¾
2.50	= 2 ¼
3.25	= 3
4.00	= 3 ½
5.00	= 4 ½
6.00	= 5 ¼
7.50	= 6 ¾
9.00	= 8
11.00	= 10
13.00	= 11 ½
15.0	= 13 ½

Handy Metric Conversion Factor

Litres per hectare $\times 0.4$ = litres per acre
 Kilograms per hectare $\times 0.4$ = kilograms per acre

Conversion Table – Metric to Imperial (approximate)**Length**

1 millimetre (mm)	= 0.04 inch
1 centimetre (cm)	= 0.4 inch
1 metre (m)	= 39.4 inches
1 metre (m)	= 3.28 feet
1 metre (m)	= 1.09 yards
1 kilometre (km)	= 0.62 mile

Area

1 square centimetre (cm ²)	= 0.16 square inch
1 square metre (m ²)	= 10.77 square feet
1 square metre (m ²)	= 1.2 square yards
1 square kilometre (km ²)	= 0.39 square mile
1 hectare (ha)	= 107,636 square feet
1 hectare (ha)	= 2.5 acres

Volume (dry)

1 cubic centimetre (cm ³)	= 0.061 cubic inch
1 cubic metre (m ³)	= 1.31 cubic yards
1 cubic metre (m ³)	= 35.31 cubic feet
1,000 cubic metres (m ³)	= 0.81 acre-foot
1 hectolitre (hL)	= 2.8 bushels

Volume (liquid)

1 millilitre (mL)	= 0.035 fluid ounce (Imp.)
1 litre (L)	= 1.76 pints (Imp.)
1 litre (L)	= 0.88 quart (Imp.)
1 litre (L)	= 0.22 gallon (Imp.)
1 litre (L)	= 0.26 gallon (U.S.)

Weight

1 gram (g)	= 0.035 ounce
1 kilogram (kg)	= 2.21 pounds
1 tonne (t)	= 1.1 short tons
1 tonne (t)	= 2,205 pounds

Pressure

1 kilopascal (kPa)	= 0.15 pounds/in ²
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Speed

1 metre per second	= 3.28 feet per second
1 metre per second	= 2.24 miles per hour
1 kilometre per hour	= 0.62 mile per hour

Temperature

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

Conversion Tables – Imperial to Metric (approximate)

Length

1 inch	=	2.54 cm
1 foot	=	0.3 m
1 yard	=	0.91 m
1 mile	=	1.61 km

Area

1 square foot	=	0.09 m ²
1 square yard	=	0.84 m ²
1 acre	=	0.4 ha

Volume (dry)

1 cubic yard	=	0.76 m ³
1 bushel	=	36.37 L

Volume (liquid)

1 fluid ounce (Imp.)	=	28.41 mL
1 pint (Imp.)	=	0.57 L
1 gallon (Imp.)	=	4.55 L
1 gallon (U.S.)	=	3.79 L

Weight

1 ounce	=	28.35 g
1 pound	=	453.6 g
1 ton	=	0.91 tonne

Pressure

1 pound per square inch	=	6.90 kPa
-------------------------	---	----------

Temperature

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$$

Abbreviations

%	=	percent (by weight)
ai	=	active ingredient
cm	=	centimetre
cm ²	=	square centimetre
e.g.	=	for example
g	=	gram
ha	=	hectare
kg	=	kilogram
km/h	=	kilometres per hour
kPa	=	kilopascal
L	=	litre
m	=	metre
m/s	=	metres per second
m ²	=	square metre
mL	=	millilitre
mm	=	millimetre
t	=	tonne

APPENDIX M: Spraying Record

This table is a spraying record form. After spraying, record the crop or field number, spraying date, material used, rate or amount of spray, weather and soil conditions at the time of spraying in the blank cells.

This table is a spraying record form. After spraying, record the crop or field number, spraying date, material used, rate or amount of spray, weather and soil conditions at the time of spraying in the blank cells.

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide call the Ministry of the Environment at
1-800-268-6060.

For pesticide poisonings and pesticide injuries call the Poison Information Centre:

Toronto 1-800-268-9017
1-877-750-2233 (TTY)

PREVENT ACCIDENTS

- **Read the label.** Follow all the precautions the label recommends. Read the First Aid section of the label **BEFORE** you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use.** Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the four basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is not a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open; wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

To obtain copies of this or any other OMAF and MRA publication, please order:

- online at www.serviceontario.ca/publications
- by phone through the ServiceOntario Contact Centre, Monday to Friday, 8:30 AM to 5:00 PM ET
 - 416-326-5300
 - 416-326-3408 (TTY)
 - 1-800-668-9938, toll-free across Canada
 - 1-800-368-7095 (TTY), toll-free across Ontario
- in person at ServiceOntario Centres across Ontario

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Have you seen these pests?

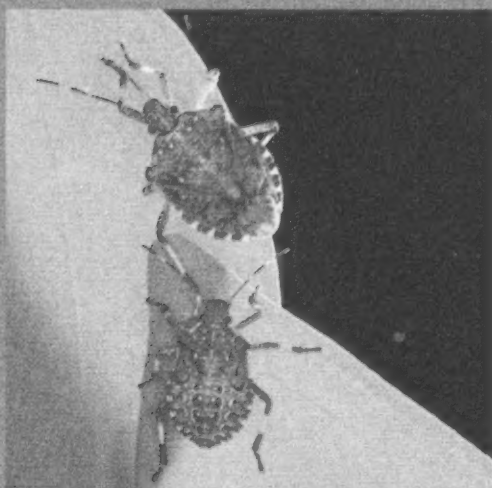
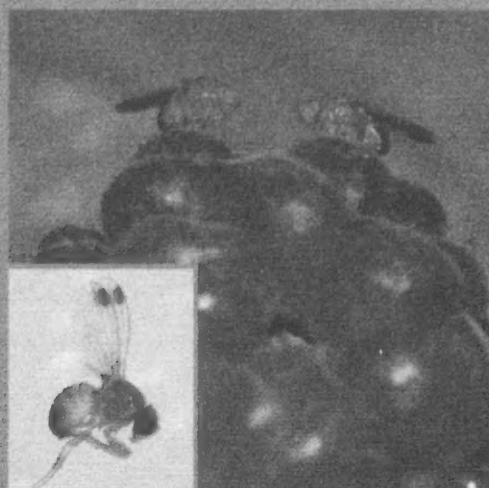


Photo credit: USDA-ARS (Stephen Ausmus)

Brown Marmorated Stink Bug



Spotted Wing Drosophila

For more information:

Visit ontario.ca/stinkbug or ontario.ca/spottedwing

Contact the Agricultural Information Contact Centre at
1-877-424-1300 or ag.info.omaf@ontario.ca